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ANTHROPOLOGY.—*New data on the inland Eskimo of northern Alaska.*[1]

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The intensified reopening of Alaska to exploration and investigation by the U. S. Geological Survey from the beginning of World War II (Reed, 1949a) has been accompanied by the promotion of new lines of scientific research. This is especially true in northern Alaska, where until recently anthropology—including its subscience archeology—had been limited to only the coastal areas or those parts of Alaska that were reasonably accessible (Larsen and Rainey, 1948, pp. 30–31). It should also be understood that, as yet, the surface has only been scratched even in those particular areas.

The express purpose of this paper is to make an appraisal of the archeological resources and possibilities for further research in the interior around the headwaters of the Colville River basin, which is situated in one of the lesser-known domains of the Territory of Alaska (Fig. 1). The government land known as Naval Petroleum Reserve No. 4 includes much of this area, which was part of the former homeland of the Nunatagmiut Eskimo, an inland people.[2] Such information as could be gleaned from related sources is included to furnish the background material for this study. This is necessary in order that our present findings may be properly correlated with previous accounts of the inland peoples. The area under scrutiny is one of the three places within the Eskimo habitat where "we do find genuine inland tribes" (Birket-Smith, 1936, p. 109). Unfortunately enough, anthropological data concerning this region are available to us now only in terms of its prehistory and from accounts of early explorers. No anthropological studies were actually made of living inland Eskimo within the Colville drainage basin.

The writer, an archeologist, was afforded an opportunity to accompany one of the U. S. Geological Survey parties during the summer of 1949 through the joint cooperation of the Bureau of American Ethnology of the Smithsonian Institution, the U. S. Geological Survey, and the Office of Naval Research. The results of his archeological investigations of the Kukpowruk and Kokolik Rivers in northwestern Alaska are in preparation, a preliminary report having been written (Solecki, in press).

Umiat, the Survey base of operations, was the assembly point of the field parties. The writer spent a few days there at the start of the season before leaving for his particular area in northwestern Alaska. Taking advantage of the opportunity, he briefed the five other Geological Survey parties in the collecting of archeological material. These parties were to examine the heart of the interior of Arctic Alaska in the lower central portions of Naval Petroleum Reserve No. 4 (Reed, 1949b). The principal drainage basin there is the Colville. It was hoped that enough field data might be collected by these geologists to furnish the framework for an overall reconnaissance report covering some of the archeology of this section of the inland region. Naturally it was physically impossible for the writer personally to communicate further archeological information once the groups had set out. The nature of the geological work kept these scientists widely separated, the writer's party being farthest removed from Umiat.

Happily, the archeological information

[1] Received March 30, 1950.

[2] The range of the Nunatagmiut Eskimo as described here is illustrated on Seltzer's map (1933, p. 320).

submitted by the geologists at the close of the field season was ample enough to permit the drawing of some inferences and conclusions. In addition, information on Eskimo sites noted by the geologists in previous years was also included. The evidence collected by men of heretofore little or no acquaintance with archeology indicates what a fertile field of investigation lies before the trained field worker there. The writer wishes to express his thanks and appreciation to those geologists from the Survey parties who supplied him with the archeological material for this report. Without this data the present appraisal of the Colville basin area and its environs would have little tangible or factual basis other than the documentary sources.

The archeology of the interior north of the Brooks Range has been literally unknown, with the exception of a brief, though important, archeological paper by Thompson (1948), a geologist who led a Survey party on the Utukok River in 1947 (Fig. 2). Helge Larsen (Larsen and Rainey, 1948) made a reconnaissance in 1942 of the same river inland from its mouth. However, a detailed account of his finds is not yet published. Though Larsen's investigations and Thompson's report, as well as the present writer's survey, are part of the archeology of this inland area, they are omitted from this paper for the sake of brevity except in passing. J. L. Giddings, Jr. (1944), has furnished us with an archeological résumé of the Kobuk River area south of the Brooks Range where he worked for two seasons. References are made to the latter's report where his findings have a bearing on the present paper. In short, this presentation deals chiefly with the archeology of the Colville River basin including some other smaller river drainages emptying into the Arctic Ocean.

Most of the data on archeological sites listed here were submitted by the members of the Geological Survey field parties at the end of the 1949 season. A total of 42 sites are included in the tabulation from the interior. Historic and recent Eskimo camp sites were recorded on the Kuna, Etiviluk, Nigu, Killik, Okpikrurak, Okokmilaga, Ayiyak, Kiruktagiak, Chandler, Nanushuk, Sagavanirktok, Shaviovik, and Canning Rivers. In addition, data were supplied from abandoned settlements, undoubtedly Eskimo, on Chandler Lake, Kanayut Lake, Itkillik, and Schrader Lakes. A total of 128 chert flakes and artifacts were recovered by the Survey from 6 archeological sites on Maybe Creek and the Kuna and Etiviluk Rivers. The writer found evidence of aboriginal occupation on a lookout station near Umiat on the Colville River.

The technique of stone chipping and the materials used in the manufacture of artifacts are of a quality which the writer (Solecki, in press) has classified as Colville Basin

FIG. 1.—Map showing location of Naval Petroleum Reserve No. 4 and physiographic provinces of the Arctic Slope. Reproduced by permission of the U. S. Geological Survey.

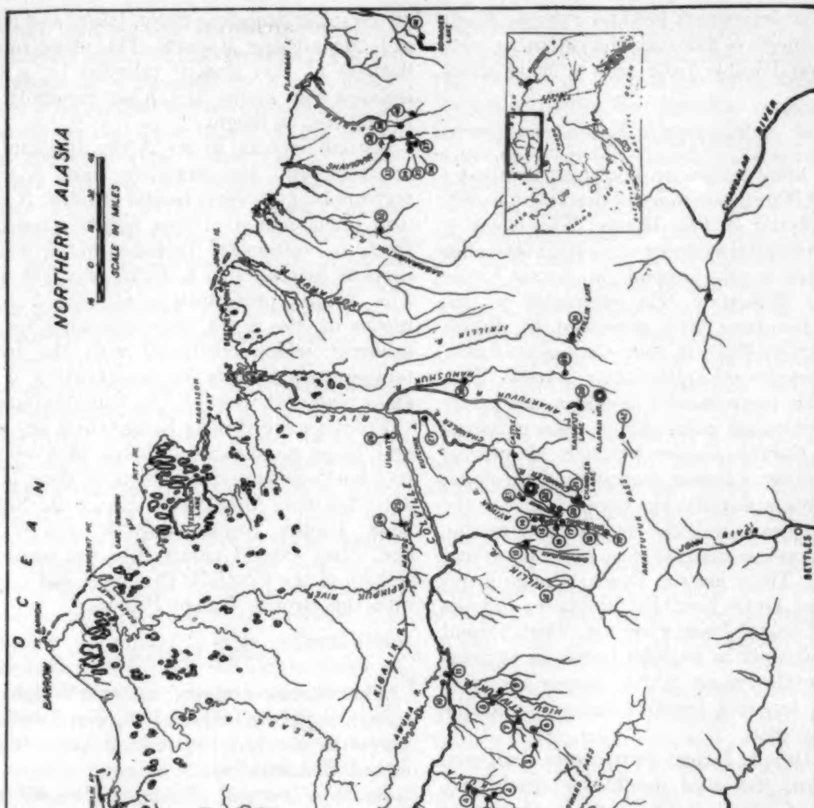

FIG. 2.—Map of northern Alaska showing the archeological sites in the interior.

Phase, or precontact Eskimo culture. Eight recent objects of more perishable nature were found on Itkillik Lake and in Anaktuvuk Pass.

THE COUNTRY

The area under exploration comprises some 70,000 square miles of desolate country north of the Brooks Range. The latter is a great mountain barrier stretching 600 miles across the north, beyond the Arctic Circle and the tree zone. The character of this region has been best described by Smith and Mertie (1930) in their *Geology and mineral resources of northwestern Alaska*. This admirable piece of work includes, like many other geological publications, data collected by the Survey parties which is of interest to the other sciences, including archeology.

Physiographically, the region between the Arctic Ocean and the mountains, or the north slope, is divided into three provinces (Fig. 1). These are the Brooks Range Province, the Arctic Foothills Province, and the Arctic Coastal Plain Province. They extend east and west in parallel bands of approximately the same width across northern Alaska, tapering together somewhat at the opposite ends.

The Brooks Range Province is composed of rugged glaciated mountains reaching a height of about 9,000 feet. It represents the Alaskan counterpart of the Rocky Mountains. Rising out of the west, this chain is breached near the middle by several important passes connecting with stream drainages to the south.

The Foothills Province is characterized by low hills and ridges. It is divided into two sections—the more elevated Southern Foothills Section bordering the mountains and the more subdued Northern Foothills Section bordering the coastal plain. The ridges in the Northern Foothills Section are in an east-west alignment, a geomorphological phenomenon resulting from a linear warping of the underlying beds. The Foothills present a bleak undulating expanse. It is treeless except on the stream borders where occasional stunted growths of willows predominate.

The Arctic Coastal Plain Province, similarly treeless, looks half drowned because of the many standing pools, lakes, and sluggish meandering streams. The monotonous flatness of this area is relieved by a few isolated low knobs and hills, generally 50 to 100 feet in height.

As one expects, in the Arctic the winters are long and the summers short with a correspondingly short period of thaw. A natural phenomenon of this region is permafrost, or subsurface frozen ground, which extends in places to a depth of 1,000 feet. The annual precipitation of only 5 to 7 inches on the north slope accounts for its aridness, which combined with the frigid temperature permits the preservation of organic matter for deceptively long time spans.

Fronting the Brooks Range there are several large mountain-fed lakes that empty into north-flowing rivers. Some of these lakes are Chandler, Anaktuvuk, Kanayut, Nanushuk, Itkillik, Saganvanirktok, and Schrader. They extend partly into the southern section of the Foothills Province, and partly into the Brooks Range Province.

THE PEOPLE

The interior country, now well-nigh deserted, supported several thousands of Eskimos in the not too distant past. These inland Eskimos were different physically from the coastal Eskimo (Larsen and Rainey, 1948, pp. 24, 36; Rosse, 1883, p. 28). They were taller and bigger-boned than the coastal people, and their facial features were more akin to the Indian physiognomy (Cantwell, *in* Healy, 1889, p. 81). On the basis of anthropometrical measurements of a sample of 526 adult Eskimos,[3] among them Nunatagmiut people (72 adult males and 55 adult females), Seltzer (1933, p. 347)[4] concludes that "the Nunatagmiut do not exhibit any close relationships with the other Eskimos." Their physical features are all "In-

[3] Data of Vilhjalmur Stefansson, collected from northern Alaska and the Coronation Gulf region in 1906–1912.

[4] Henry B. Collins, Jr. (1934, pp. 309–313), has discussed Seltzer's paper in a critical review, pointing out that the latter's conclusions relative to Eskimo cultural and somatological connections leave much to be desired. Collins's (p. 313) summary of the physical anthropology of the Eskimos indicates that much caution should be exercised in making any final conclusions on the subject of Eskimo origins, etc., at present.

dian-like and clearly betray the presence of considerable blood that must have entered this group in comparatively recent times" (ibid.). The Indian mixture to which Seltzer refers is Athapascan. Some of the inland male Eskimos were 6 feet tall and over (Brower, 1942, p. 227; Rosse, 1883, p. 28). Seltzer (1933, p. 341) gives a mean stature of 169.12 ± 0.90 cm for the measurement of 26 male Nunatagmiut Eskimos, or about 5½ feet tall. However, these "present the tallest mean statures that heretofore have been assigned to any Eskimo" group (Seltzer, 1933, p. 342).

It appears from the following reports that these nomadic peoples died in great numbers of starvation and disease in the latter part and at the turn of the nineteenth century (Brower, 1942, pp. 37, 228–229; 1949). Rosse (1883, pp. 16–24), a physician, deals with the diseases of the Eskimos at some length. His firsthand observations are particularly important since they were made when the native populations began to dwindle. Undoubtedly the inland Eskimo suffered from diseases and afflictions similar to those of the coastal Eskimo, whom Rosse observed. Howard (*in* Stoney, 1900, p. 74) in 1885 saw many sick people in the mountains, especially women and children, who appeared to suffer from severe colds. It was not long after this that the tragedy of influenza struck (Brower, 1942, pp. 228–229; 1949), probably resulting in the death of these very people. Brower (ibid.) recorded in 1900 that about 200 inland Eskimos, all visitors to Point Barrow who had contracted influenza there, died all along the way homeward, from the mouths of the rivers to the portage and to the Colville. The bodies of the dead, their boats, and belongings were found scattered everywhere on the inland routes. This catastrophe was followed two years later (1902) by an epidemic of measles, which caused 120 deaths at Point Barrow alone. Thus it was that the Eskimos, like other nonliterate peoples everywhere before them, finally felt the full impact of white man's diseases. There the populations were ravaged by smallpox, diphtheria, influenza, measles, and tuberculosis, among other diseases. Whiskey also contributed much to their debilitation (Rosse, 1883).

A few inland Eskimos apparently escaped extinction, since some of them came down the rivers to Barrow in 1908 and 1931 (Brower, 1949). No mention is made by Brower of visits of inland peoples between those years, an omission that seems to carry portentous meaning.

So far as it is known, there is only one band of truly inland north slope Eskimos left. This band, the Killik Eskimos, are divided into two groups of families numbering 40 or 50 persons including children. Living in the Southern Foothills region and the mountains near Chandler Lake, these modern Eskimos are still dependent on the caribou and the products of the hunt for their livelihood. The statement made by Larsen and Rainey (1948, p. 24) that "the vast Arctic slope north of the Brooks Range has been entirely abandoned only during the past 20 or 25 years," is not yet completely true, since there still survives the one band mentioned. Presumably it is to them that we owe the indications of recent camp sites in the neighborhood of the upper Colville and adjacent tributaries.

The ethnological record of the interior Alaskan or western Eskimos north of the Brooks Range is very meager, since none of the several northern interior tribes have been studied by anthropologists. We are helped with a few notes made by early explorers, notably Ray, Stoney, Healy (et al.), and Stefansson. The last small Eskimo groups mentioned above are dwindling away rapidly. The extreme inaccessibility of their habitat has probably been the paramount cause for their neglect and our lack of data.

Our knowledge of the historic inland northern Eskimos may be summed up in a few paragraphs. Stefansson (1914, pp. 9–11) mentions seven inland tribal bands, namely the Kuvugmiut, Noatagmiut, Nunatagmiut, Kangianirmut (Kanianermiurt), Oturkagmiut, Killiermiut, and Kagmallirmiut. These Eskimo bands were distributed over different important inland rivers. The name of a small band, Nunatagmiut,[5] nearly extinct at the

[5] Larsen and Rainey (1948, p. 24, pp. 30–36) refer to these inland Eskimos as "Nunatarmiut," having a distribution practically similar to Nelson's "Nunatagmiut" (Nelson, 1899, pl. 2). In order to avoid confusion, Stefansson's collective term "Nunatagmiut" is used in this paper.

time of Stefansson's writing (in 1908), has been applied collectively to all northern inland Eskimos by both whites and coastal Eskimos alike. The reason given was that this band was centrally situated near the head of the Colville River.[6] There seems to be some elusiveness and uncertainty about the use of this name. Birket-Smith (1936, p. 225) calls these inland Alaskan Eskimos the "Colville Eskimos" and assigns the Nunatagmiut to the Noatak River. Perhaps the best authority to speak on this subject is Stefansson (1914, pp. 10–11) who says:

> It seems fairly clear that the name of this smallest of all these inland tribes became recognized on the coast as the name for them all because they were centrally located. From the point of view of the Barrow people, the Nunatagmiut were south of the Oturkagmiut; . . . For each of these sections of the country, therefore, Nunatagmiut became the indefinite name that covered the people next beyond those who were personally known to the speakers, and thus the word obtained a comprehensiveness of meaning on the seacoast which it never had among the inlanders themselves. Now you find it in census reports and works of ethnology.

Recognized wintering places were many on the Colville and its tributaries. There is abundant evidence, as shown below, that the Nunatagmiut were on intimate terms with the natives of the Noatak and Kobuk Rivers across the mountains to the southwest, as well as with the Colville delta and Point Barrow Eskimos. They seemed to have served as middlemen in trading between these two regions.

The expeditions of Lt. P. Henry Ray, U. S. A. (1885), Capt. M. A. Healy, U. S. R. M. (1887, 1889), and Lt. George M. Stoney, U. S. N. (1900), made almost simultaneously in the early part of the 1880's, furnished some pertinent information about the inland Alaskan Eskimos. Lieutenant Ray, based at Point Barrow, made a short exploration of the Meade (Kulugrua) River to the south from its mouth to the foothills, or the mountains as he called them. He reached to about the seventieth parallel. Captain Healy's parties made exploratory boat trips up the Noatak and the Kobuk, mainly of a reconnaissance nature. Lieutenant Stoney, based on the Kobuk (Kowak, Putnam) River, made two trips into the interior mountain region, one up the Noatak, and the other up the Kobuk to Chandler Lake. One of Lieutenant Stoney's subordinate officers, Ensign W. L. Howard, made a memorable journey in 1886 between the headwaters of the Noatak River to Point Barrow via the Etiviluk, Colville, and Ikpikpuk (Chipp) Rivers (Fig. 3). These explorers followed native routes of travel and were accompanied by native guides. Some idea of Eskimo inland life can be had from a study of these firsthand reports. About this time in the latter part of the nineteenth century, inland Eskimo habitat north of the range seems to have centered in the southern Foothills Province, close to the mountains rather than in the northern part of the same province or in the Arctic Coastal Plain Province. This we gather from Ray and Stoney. The former (Ray, 1885, p. 38) writes: "Between Pt. Barrow and the Colville, the country is uninhabited in the winter. The resources of this region are so limited that in the struggle for existence, these people are obliged to devote all their energies and time to procuring necessary food and clothing to maintain life, never being able to get a sufficient supply of meat ahead to lay in a reserve; famine always stares them in the face should they try to relax their efforts." Similarly, at the time of Stoney's winter visit to an Eskimo village in the mountains on Chandler Lake, he learned that there were no natives between that inland lake and the northern coast (Stoney, 1900, pp. 44–45). It is very likely that the whole of the region below the headwaters of the rivers was forsaken during the winter or had been deserted as claimed below. Stoney tells us that only a few of the inland natives went to the Arctic coast to trade, the "majority continue in the mountains, living almost entirely on deer meat." Some of the Kobuk River natives came to pay them annual visits during the winter to trade and to hunt deer during their stay (Stoney, 1900, p. 45).

[6] The Colville River, the longest and largest river on the north slope, was named by Dease and Simpson after Andrew Colville of the Hudson's Bay Co. in 1837. One of the Eskimo names for the Colville is "Kupik," meaning "big river." This was spelled "Gubik" by the geologist Schrader, who gave this name to the Pleistocene sand deposits in northern Alaska (Schrader, 1904, p. 93; Leffingwell, 1919, pp. 74, 95).

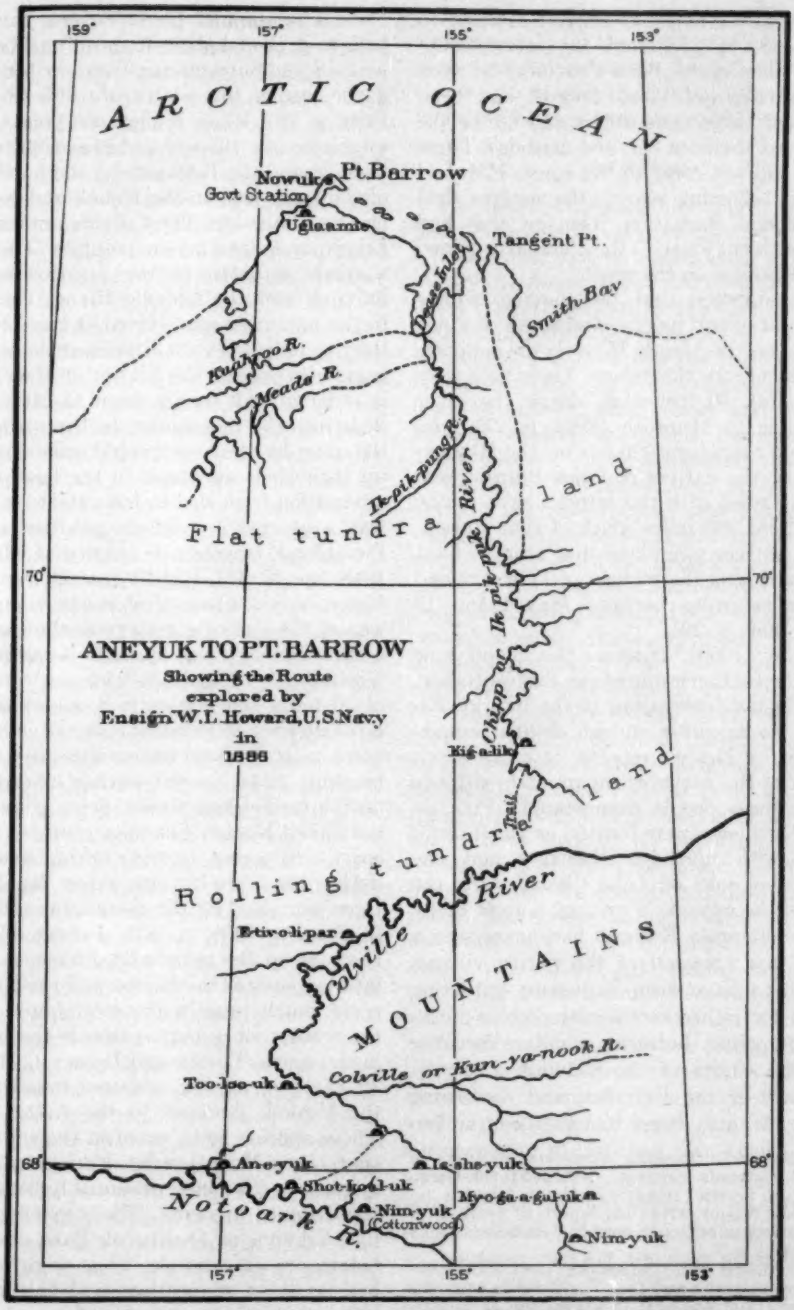

FIG. 3.—Map showing route of Ensign W. L. Howard, U.S.N., in 1886.

The natives at Point Barrow asserted to Ray (1885, p. 27) that the intermediate region (the Coastal Plain Province) between the Colville and Point Barrow had been inhabited three generations ago by people who lived there on fish and caribou.[7] These people did not come to the coast. Fish and caribou becoming scarce, the natives died of cold and starvation. The few that had survived went away to the Colville or joined other Eskimos on the coast.

Ray supposed that the ruins of winter huts built of turf he observed south of Point Barrow on the Meade River is the supporting evidence for this report. These huts were on a bank 50 feet high above the river According to Murdoch (1892, p. 27), who recorded ethnological notes on the Ray expedition, the natives of Point Barrow were unacquainted with the interior save for an area about 100 miles south of that station. These natives went into that area to hunt caribou during the months of February and March, returning between May 1 and 10 (Ray, 1885, p. 39).

Stoney (1900),[8] entering the inland zone from the southern side of the Brooks Range, gives us his descriptions of the interior Eskimo. He furnishes enough details, supplemented by Healy's reports, to make a fair sketch of the native economy and existence before these people disappeared.[9] Five inhabited villages were located on the interior rivers with northern drainages and one (Nudruvukpuk) on Lake Chandler. At the time of the explorer's writing, a great many of the mountain Eskimos had never seen a white man. Several of the native villages appear to have been important gathering places for either ceremonial reasons or as portage points. Issheyuk, a village near the northern limits of the Etiviluk River (a tributary of the Colville), and containing about 15 huts, seems to have been an important ceremonial place. Several hundred natives gathered there from all parts of the Noatak and surrounding territory for a big dance during the winter of 1885 (Stoney, 1900, p. 39). River rendezvous points were established at the end of navigation on the Colville and the Ikpikpuk on the north side of the range and on the Kobuk and Noatak on the south side. The Colville rendezvous, Etivilipar, is used as an example. This was a village situated at the junction of the Etiviluk and the Colville River. The trail to the mountain pass (Howard Pass) led up the Etiviluk River. At Etivilipar the natives going upstream in the fall put up their boats in order to wait for the snow to carry their sleds into the mountains. In the spring, on the other hand, those going downstream put up their sleds and took to the boats. This alternation from sled to boat and vice versa was a general convenient practice among the inland travelers (Larsen and Rainey, 1948, pp. 32–33). Kigalik, on the Ikpikpuk River, was another rendezvous village. It was at the end of a trail from the Colville, a short cut to Point Barrow. According to Howard, the Kigalik settlement consisted of 30 tents and 150 natives, all waiting to go down river to Point Barrow. They boated down with the flood waters just after spring breakup, when a swift voyage was assured on the meandering rivers. Some tribes, like the inland Noatak Eskimos, returned to the coast each spring, hunting in the mountains during the winter. Only a few families of these remained in the mountains (Howard *in* Stoney, 1900, p. 67). Presumably the Eskimos on the peripheral drainages of the interior, such as the Kobuk and the Noatak, spent much time in the mountains during the winter, since that season is the longest in the north. Larsen and Rainey (1948, pp. 32–34) describe the seasonal migration of the Utukok Eskimos to the Arctic coast. There appears to be proof in the statement that some Nunatagmiut Eskimos did not migrate to the coast, presumably because of the distance involved. The surviving "Killik" Eskimos of Anaktuvuk Pass, described below, are an example. They seem to have had no direct connections with the coast in either the present or past, so far as could be ascertained recently.

[7] "Caribou" (*Rangifer tarandus arcticus*, or Barren Grounds caribou), is the French-Canadian word for wild reindeer of North America.

[8] Since Stoney wrote his report 15 years after his visit, some errors or doubtful statements may have crept in.

[9] Stefansson wrote in 1908 that the Colville people were starving and that the Colville area was too uncertain for food. The desertion of this region was remarked about among coastal Eskimos, a significant point (Stefansson, 1914, pp. 190, 208).

LIVELIHOOD

Caribou hunting dominated the livelihood and economy of these inland Eskimos. On the hills above the rivers were posts from which sharp lookouts watched for caribou. When the quarry was sighted, all the young men would leave for the chase. All work was suspended to hunt the caribou. The women brought in whatever was killed to be dressed and prepared. In the flat Coastal Plain Province, game kept to the lakes rather than to the river as in the Foothills. It seems that caribou were especially abundant on the headwaters of the Colville, Kobuk and Noatak Rivers in the mountains (Cantwell, *in* Healy, 1889, pp. 61, 80), which was no doubt the cause for native habitat there.

The caribou drive, requiring cooperative efforts, was not unknown to the Nunatagmiut. From the large herds as many as 25 caribou were caught by running them into a trap consisting of two converging rows of stone cairns terminating in a network of snares in the bushes. The cairns[10] were piles of stones about 4 feet high, resembling men at a distance. Shouts and flourishes from the side lines and the rear frightened the animals forward to what appeared to be a break ahead. The snares caught either the horns or the legs of the caribou, hampering them until they were despatched at short range by the hunters (Stoney, 1900, pp. 68, 74, 94). This method of trapping, one of several, is not unusual in the north (Larsen and Rainey, 1948, p. 34; Birket-Smith, 1936, p. 91). Charles Brower (1942, pp. 168–169; 1949) describes a caribou drive in the lake country. The caribou were driven between two long rows of sod cairns, which narrowed down to a point of land leading to a lake. The caribou, forced to plunge into and swim in the lake, were speared by hunters who lay in wait in their concealed kayaks. As many as a hundred were killed in these drives. Pitfalls (Brower, 1949, p. 34) dug in the snow were another means of trapping caribou. The pits were about 6 feet deep, 2 feet wide, and just long enough for the caribou to stand in without moving. The opening was disguised with a covering of willows overlaid with snow.

[10] Many of these structures still may be seen on the ridges in the Foothills Province.

The inland Eskimo diet of caribou was supplemented by the meat of other animals such as bear, mountain sheep, and moose. Geese, ptarmigan, fish, and other edibles including berries were also eaten.

SHELTER

The inland Nunatagmiut appear to have had four kinds of habitations, and possibly a fifth. These were semipermanent and temporary dwellings. What seems to be an unusual type of the former structure held several families (Stoney, 1900, p. 46). A frame of mountain willows was the basic element of construction. This was generally long, low and narrow. Each family had its own ice-cake window, smokehole, and fireplace. There were ice windows alongside the doors at the ends. The frame, held up by a few uprights or "centerposts," was roofed with turf and reindeer moss. It was then covered with a layer of snow. Larsen and Rainey (1948, p. 35) describe another type of semipermanent inland Eskimo house with a single central fireplace. Quite substantial looking, semisubterranean houses, also semipermanent, with central fireplaces, were uncovered by Giddings on the Kobuk River (Giddings, 1944). Probably there are similar archeological remains of these dwellings such as illustrated by Stoney (1900, p. 40 illus.) on the upper Colville. However, since all timber would have had to be imported for the center posts of this type of semipermanent house, it may be conjectured, not without reason, that a more simply constructed house was commonly built. In addition, a more simply constructed hut, readily adaptable to the nomad life, would seem to be preferable. The dome-shaped willow hut[11] met the needs of frequent movements readily. It was light in construction, and could be adapted for either summer or winter use. It was made by bending and interlacing willows to a dome-shape of less than man height, with a circular floor plan. A roof covering of deer skins sufficed for the summer. A layer of soft snow about 6–8 inches thick was patted on the surface, making the hut snug in the

[11] Jenness (1934, p. 402—footnote, p. 412) feels that "some inland Eskimo of northern Alaska" copied the dome-shaped hut from the Kutchin Indians of the Athapascan linguistic stock.

winter (Stoney, 1900, p. 46; Stefansson, 1914, p. 206). When one desired to shift winter camps, the tent and poles were taken down from the inside, leaving the snow house up unless broken. To what extent the conical skin hut or "lodge" (E. W. Nelson, 1899, pp. 231, 242) was used in the Colville basin we are not certain. However, there seems to be adequate documentation supporting the dome-shaped as the prevailing type of dwelling. Healy (1889, pp. 80–81) mentions the dome-shaped hut on the Kobuk. Marvin Mangus, of the U. S. Geological Survey, has observed recently the plaited and bent willow frames of this house type on the Killik River on the north slope. The method of construction of one of these huts is illustrated by Leffingwell (1919, pl. 8B). The latter also shows a winter camp in use. Without doubt this is one of the easiest temporary dwellings to construct when on the move. A dome-shaped hut is also certainly the most feasible type of house to erect with native willows in the absence of larger trees.

Larsen and Rainey (1948, pp. 56–57) believe that the dome-shaped, snow-covered tent is the prototype of the real snow house. The latter presumably finally developed in the central regions of the Arctic. Howard (*in* Stoney, 1900, p. 67) mentions huts in the mountains made of blocked snow, with roofs "formed by overlapping the higher layers."

TRADE

The Eskimos of the Kobuk and Noatak Rivers held a kind of summer fair at the head of Kotzebue Sound,[12] where extensive trading negotiations took place. Parties of traders from East Cape, Siberia, and the Diomede Islands introduced the intercontinental flavor with their wares (Nelson, 1899, pp. 228–232). There was a flourishing trade among the Kotzebue Bay people, the Nunatagmiut and the Point Barrow people. Jenness (1934, p. 23) lends additional weight in the following statement: "A hundred years ago there was a well defined trading route that commenced at Anadyr, the Russian mart near Bering Sea, crossed Bering Strait to Kotzebue Sound, then continued overland to the mouth of the Colville River and eastward to the delta of the Mackenzie." It seems quite plausible to hypothecate Eskimo migrations along this route.

Certainly the introduction of sleds and dog traction affected travel and trade considerably. However, we have archeological evidence indicating that these were comparatively late innovations. Giddings's data (1944, 1948) unearthed on the Kobuk has important bearings on this subject. Ahteut, the oldest Eskimo site on the Kobuk River uncovered by Giddings (1944, pp. 123–124, 127), shows absence of any signs of sledding or dog traction. Giddings has given a date of A. D. 1200–1250 for Ahteut, part of a continuous dendrochronological record of 970 years in Alaska. Evidences of sleds first appeared among the Kobuk River people in the first half of the sixteenth century, and "swivels, etc." for dog traction after 1700 (Giddings, 1948, p. 32). Presumably this would also hold true for the prehistoric Eskimos of the Noatak River and the Colville Basin drainage. Absence of dog traction and the sled would necessarily hinder winter family movements, confining travel to the open waterways during the summer season (Giddings, 1944, p. 124). Hence, we must infer that since travel through the mountains to the northward-flowing drainages was to be negotiated by portage, the natural difficulties inherent without dog traction or sleds made such travel prior to their introduction probably either out of the question or very infrequent. This, of course, applies more specifically to seasonal long-distance journeys. Consequently, we might expect that the northern interior areas were not visited by many Eskimo family groups until after dog traction and sleds were introduced in about the sixteenth century, at least for the latter innovation. There is archeological evidence indicating that these two traits were also comparatively late in other places (Collins, 1937, pp. 338–341; Larsen and Rainey, 1948, p. 186). It is possible that there were year-round occupations of the mountain areas

[12] Kotzebue, the "native trading rendezvous" located on Healy's map (1887) at the junction of the Kobuk and Noatak Rivers on Hotham Inlet, Kotzebue Sound, is probably the age-old trading point still in use. The present status of Kotzebue archeology is summarized by Giddings (1944, pp. 128–130).

prior to these introductions. Proof of this would have to wait on archeological investigations.

Resuming our discussion of inland trade, Stefansson (1914, p. 10) observes that the Eskimo from the Colville area obtained "Asiatic and other wares" from the trading rendezvous on Kotzebue Sound. Trade over the mountains from the southern drainages to the Colville headwaters was accomplished in a 10-day portage during the winter (Cantwell, *in* Healy, 1887, pp. 45–46). Stoney (1900, p. 39) said that the mountain natives went to Point Barrow every summer, proof of which he saw in the army clothing worn by them, evidently obtained from the Army post formerly under the command of Lieutenant Ray at Point Barrow. A family or two often stayed on the northern coast for a visit during the winter. There was a regular exchange of definitely needed goods and some luxury items between the inland people and the coastal natives. The former Eskimos had caribou skins, mammoth-tusk ivory, tent poles, and wood to trade for seal-oil, rifles, blubber, seal skins, tobacco, etc. (Stoney, 1900, p. 68, 76; Larsen and Rainey, 1948, p. 33). Jade, a highly prized commodity for trade, was secured from the upper Kobuk River in the central part of that valley basin. This widely traded material was mined only under the observances of certain taboos according to the early explorers (Stoney, 1900, p. 46). Chert for the manufacture of flaked implements was traded to the Point Barrow Eskimos from the Nunatagmiut. It was generally a black or a translucent gray chert (Murdoch, 1892, p. 60).

Trade and traffic between the drainages north and south of the Brooks Range depended on passes over the divide. Good pass routes through the mountains are limited. Three good ones (Fig. 2) athwart the Endicott Mountains of the Brooks Range were probably used exclusively for traffic and trade. They connect fairly well with a minimum of portage between the drainages of the Colville River and the southern rivers. Howard Pass joins the headwaters of the Noatak with the Etiviluk River, a branch of the Colville. Stoney approached Chandler Lake going over the mountains by another route at the headwaters of the Kobuk River, through a low pass now known as "Survey Pass."[13] The third good pass to the north is Anaktuvuk Pass, which leads from John River on the south side of the divide to the northward-flowing Anaktuvuk River. This route, followed by Schrader (1904, pp. 21–22) in 1901, is the one which the surviving "Killik" Eskimos use today between Chandler Lake and the town of Bettles on the south side of the mountains. Six different mountain trail crossings were used by the geologists as shown on the "Geological Reconnaissance Map of Northwestern Alaska" (*in* Smith and Mertie, 1930, pl. 2). Three of these (Howard Pass, Survey Pass, and Anaktuvuk Pass) have been mentioned above. The others are situated in the western sector of the Brooks Range. The latter passes were probably not as much favored as the more direct links between river drainages, since they are a bit too far westward for easy connection.

RECENT INVESTIGATIONS AND FINDINGS

By the time the geological surveys[14] of the early twentieth century explored the north over a generation ago, the inland settlements had vanished, and no recent signs of large communities were found. As Smith and Mertie (1930, p. 110) said, "even signs of old habitations are rare." These authors note that there were signs of man on many of the prominent knobs north of the Brooks Range, indicating that these promontories had been used as lookout stations by caribou hunters. The ruins of 15 or 20 huts were seen on the headwaters of the main branch of the Colville River, above its junction with the Kuna River. These huts had obviously been deserted for a long time. With the exception of two old willow hut frames, some discarded tin cans and other recent camp debris, no indications were found of the large settlement where Howard

[13] Called "Navy Pass" on Stoney's map (1900).

[14] John C. Reed (1949a, b) has given us an inkling of the recent survey work in northern Alaska in two articles. Up to the present, no full account has been released. Smith and Mertie (1930, pp. 8–27) give a summary report of the Geological Survey work done in the north between 1901–1926. Earlier investigations are included by the above authors in the same work on pp. 4–7.

waited three or four days at Etivilipar on his trip to Point Barrow. The only aboriginal artifacts specifically mentioned by Smith and Mertie were "exceptionally well fashioned" spear heads. These were found on the Awuna River, a short distance above its juncton with the Colville, near an old native camp site. Evidences of an encampment were found near the summit of Birthday Pass in the same area. The remains of a village site were found in the basin of the Ikpikpuk River a few miles above the junction of Kigalik River and Maybe Creek. This site appears to mark the north end of the portage from the Colville (Smith and Mertie, 1930, p. 111). These geologists noted that:

> This place must have been at one time the home of numerous natives, as is indicated by the worn-out and discarded gear and ruins of houses, many of which were dug down several feet below the terrace flat on which they were built. Large willow tripods, evidently used for hanging up meat, showed that this place had probably been last used by hunters, but the rotten condition of the rope and canvas which together with willow withes had been used for fastening the legs of the tripods proved that they had not been used for many years. A few miles farther downstream, at the junction of the Kigalik River and Maybe Creek, there are indications of a formerly very populous settlement. This is undoubtedly the village noted by Howard in 1886 as Kigalik, which at the time of his visit consisted of 30 tents and 50 natives.[15] No huts remain, and the tract does not appear to have been used even by chance travelers for many years.

There were many signs of smaller former occupations or camps farther down on the Ikpikpuk River. Summarizing Eskimo habitations and occupations in the north, Smith and Mertie (1930, p. 112) state, "The same general conditions prevailed in the valleys of all the other rivers flowing into the Arctic Ocean. On none of them were there any occupied settlements, and on few of them were there any signs of camps that had been used for any length of time recently."

One wonders, however, how many and which of these sites are attributable to coastal Eskimos on the hunt, or to "genuinely" inland Eskimos or both. It would seem that the smaller camps may possibly be those of wandering hunters coming up the rivers from the coast.

Some data, part of which is given below, were collected with reference to the sole survivors of some true inland mountain Eskimo by George A. Llano, botanist for the Department of Botany, U. S. National Museum. Dr. Llano had occasion to visit the Anaktuvuk Pass area at the headwaters of the Anaktuvuk River during the summer of 1949. He took some photographs and made some observations. The Anaktuvuk Pass area where the "Killik" Eskimo camped was favorably situated. According to Dr. Llano's report, these mountain people rarely if ever came down to the seacoast. They are nomadic hunters; their main means of subsistence are the caribou. The Killik Eskimo travel back and forth between Bettles, where they winter, and the Anaktuvuk Pass area, Chandler Lake, and environs, where they spend the summer. These Eskimos are divided into two groups of families, one of which is headed by Simon Paniak who is said to be an able leader. This group consists of five families. Each family has about four members, which makes a total population of about 48 individuals in the Killik tribe. Though these Eskimos are often completely isolated, they are not without contact from the outside world. They have guns and other equipment. One of the richer men (the best wolf hunter) owned four portable radios and other knickknacks purchased with the wolf bounty and furs. Like the other Eskimos, they are quite adept at using mechanical equipment and can improvise readily. In one instance, they patched up the wrecked float of a seaplane well enough for it to take off again. Their best routes of travel are up and down rivers following the natural levels. There is abundant occupational evidence and ruins marking old unmapped camp sites in Anaktuvuk Pass. In their tradition, as far back as the Killik Eskimos can remember, they have always camped in this region. These natives sincerely wish to have an education. They mistakenly moved bag and baggage to the Anaktuvuk Lake area thinking that school would be held there during the summer of 1949. For the present, no teacher has been provided for them.

[15] The number of natives was evidently a misprint, since Howard (*in* Stoney, 1900, p. 71) saw 150 Eskimos at Kigalik.

INLAND ESKIMO ORIGINS

The origin of these inland Alaskan Eskimos is in doubt. Birket-Smith (1936, p. 112) believes that the Colville and Yukon Eskimos originally lived on the coast in the usual manner and wandered inland. This implies that the coastal Eskimos had followed up the drainage systems nearest them. Stefansson (1914, p. 23) suggests the possibility on a linguistic basis that the Eskimos may have worked their way westward into Alaska along the Arctic coast and followed the shore around down to Kotzebue Sound. From there, Stefansson continues, a branch of the coastal Eskimo may have traveled up the Noatak River, across the divide, and back down the Colville. Certainly this clue should not be disregarded in the future unraveling of Eskimo archeology in the northern interior. Seen in the broader perspective, we still at best must theorize about the origins of Eskimo culture in North America. As Collins (1940, p. 583) points out, "The archeological discoveries in the north, instead of providing immediate evidence of the origin of Eskimo culture, have shown that it will be necessary to extend our search still farther into the past if that origin is to be revealed."

THE ARCHEOLOGY

Of the 42 sites listed below in the appendix, the majority were found in the central portion of Naval Petroleum Reserve No. 4 (Fig. 2). Data were supplied for 38 of these sites by the field party chiefs and members of the U. S. Geological Survey.[16] Two sites (nos. 8, 11) were native encampments visited by Howard in 1886. One site (no. 26) was found by the writer during a brief stay at Umiat. The Anaktuvuk Pass area is indicated as one site (no. 42).

[16] The party chiefs and personnel of the U. S. Geological Survey who supplied the information are listed below. The site numbers of those particular sites which they reported are added to their names.

Arthur L. Bowsher: Sites 28, 29, 31.

William D. Brosgé and Alan Kover: Sites 24, 25.

Robert L. Detterman and Marvin D. Mangus: Sites 1–7, 9, 10, 12, 30, 36.

William W. Patton and Irving Tailleur: Sites 13–20, 22, 23, 27.

George Gryc: Sites 21, 28, 32–35, 37–41.

Eskimo occupational evidence has also been noted by geologists exploring the northeastern parts of Alaska within the past few years. These remains were seen on the Sadlerochit, the Hula Hula, and Jago Rivers, but no details can be given.

It must be kept in mind that the geologists, specializing in their own work, were not trained archeologists. Their descriptions are entered below as accurately and as fully as possible. Enough data were recovered to make a positive assertion that archeological materials are to be found over a widespread area in the interior of Arctic Alaska.

The specimens are described at the end of this section. The chipped stone artifacts from sites 1, 2, 4, 7, 9, and 30 were retained by their finders.

The sites are arbitrarily numbered on the map, following the different drainages from west to east. No numerical differentiation is made between old and recent Eskimo sites. The assemblage of sites may be divided into three divisions on the basis of the reported associated evidence. These are (a) precontact Eskimo sites, (b) recent Eskimo sites, and (c) sites of indeterminate age, presumably Eskimo.[17] The information is insufficient to indicate whether or not the sites in group (c) belong to group (a) or (b).

The archeological material from group (a) examined by the writer is similar to that classification of precontact Eskimo flaked artifacts he has called "Colville Basin Phase" (Solecki, in press). No sites of pre-Eskimo origin were reported, or more specifically, no specimens of recognizable pre-Eskimo origin were recovered. An especially important point to carry in mind is that undoubtedly many archeological sites had been passed over by the geologists in the field. Since evidence indicating precontact sites is not particularly easy to find even by trained archeologists, these sites as reported by the geologists are in the minority.

The sites in group (a) were lookout stations, or places where the hunters lay in wait for game. Presumably in their leisure, the lookouts flaked their knife blades and projectile points, hence also the name "chip-

[17] Included in group (a) are sites 1, 2, 4, 7, 9, 25, 26, 30; group (b) sites 3, 5, 8, 10–13, 15, 16, 18, 20–23, 27, 28, 31, 32, 37, 38, 40–42; group (c) sites 6, 14, 17, 19, 24, 29, 33–36, 39.

ping station" for these places. These stations were generally situated on low promontories with a good view of the surrounding country, usually near a river or creek. Howard probably saw some of the same lookout stations on the Etiviluk River in use when he went down that river in 1886 with the inland Eskimos.

The stone rings appear to be of two types: (1) Flat stones laid in a circle, and (2) rings of stone arranged for a hunter's blind or windbreak. The former arrangement of stones was presumably for the tent floor and weights to hold down the edges of the tent. The blinds were constructed by either piling stones on the flat sides, or propping them up on edge high enough to conceal the hunter or hunters. A hunting blind could serve equally well as a windbreak—almost a necessity on the hills and ridges where the wind could whip up uncomfortably in gale force during freezing temperatures. The "house" circles of stone were found along the rivers as well as on the hills above them.

Only one of the reported stone house circles (site 29) seemed to have a fireplace in the center. Unfortunately, it was not further investigated.

Stone trail markers and cairns are present on some of the ridges. The cairns, usually in an alignment, are evidently part of the Eskimo caribou drive (site 17).

The recent Eskimo camps were rather obvious to their finders. The camp debris generally consisted of cut willow boughs, hut remains, tin cans, drying racks, discarded clothing, large quantities of animal bones, etc. The animal bones represent the whole animals, including the heads and feet.

Evidence was found on a site (no. 20) on Kiruktagiak River indicating that the Eskimos used oil shale for fuel. This is nothing new however, since the Nunatagmiut burned it at least 64 years ago (1886) on the Etiviluk River (Stoney, 1900, p. 69).

How much of the recent evidence is attributable to the occupancy of the Killik Eskimos is not certain. However, since these people are apparently the only inland Eskimos who are dwelling in this region in any numbers at present, it does not seem farfetched to assume that they are responsible for the principal, if not all, of the recent occupational remains. The domain of the Killik Eskimo is not known for certainty, but they probably kept to within 75 to 100 miles of Anaktuvuk Pass in the Southern Foothills Section. The recent occupational remains found by the geologists on the drainages in the northeastern part of Alaska might be evidence of native hunters from the coastal region. On this point we are not certain at present.

Every one of the sites indicated in the tabulations will bear reexamination by a trained investigator. In addition, new sites undoubtedly would be found and recorded in the course of a survey. Presumably "key" sites may be located, such as the portage places mentioned by Howard, and seen by later geologists (Smith and Mertie, 1930, p. 111). How much pre-Eskimo material there is at present on the north slope can only be speculated on at this time. However, since this region was one of the unglaciated places close to the Asiatic-American bridge, there is hope of recovering this data. One Folsom point, reported by Thompson (1948) has already been found on the Utukok River in northwestern Alaska, and the writer (Solecki, in press) has found two sites bearing so-called "Mongolian" cores and flakes on the Kukpowruk River in the same section of Alaska.

CONCLUSION

It has been demonstrated above that archeological evidence is not lacking in the interior of Arctic Alaska beyond the tree zone. It has been shown that along the larger drainages and on the hills overlooking the valleys, especially in the Foothills Province, there may be discovered cultural material pointing to occupation by a prehistoric population or populations. We know from documented sources that Eskimos inhabited or at least frequented the north slope in the nineteenth and early twentieth centuries. These people were physically different from the Coastal Eskimos, being taller and more Indianlike in features (see *The People*, above). At this writing only one surviving band of inland Eskimos, the Killiks, is still dwelling in the mountains.

The greatest single difference between the inland Nunatagmiut Eskimos and the coastal Eskimos appears to be their economy or method of subsistence, as observed by Larsen and Rainey (1948, p. 35). The Nunatagmiut depended almost wholly upon caribou for their meat, shelter, and raiment. Probably like so many nonliterate societies dependent on one economy, when the ecological balance was upset, the Nunatagmiut culture was doomed. So far as can be gleaned from limited literary sources, it was scarcity of game, principally caribou, which was the prime cause for the desertion of inland northern Alaska and the extinction of these peoples. Sickness also played a major part in the depopulation.

It appears that the Nunatagmiut were "habitually inlanders" (Weyer, 1932, p. 157) who had interrelations with the coastal Eskimos via the larger drainage systems on both sides of the mountain divide. Certainly the inland region was not uninhabited by indigenous populations when the first ethnologists arrived in Alaska. According to the little documentary evidence available, six inland bands, comprising the Nunatagmiut, had semifixed boundaries or "spheres of influence" on the several interior drainage systems. Their tribal relationships were recognized among themselves.

Some inkling of the movements of the postcontact inland Eskimos on the north slope of Alaska is suggested by the literature. Whether archeological work in the future might corroborate this is not certain. However, with further information we should be able to make a more definite statement concerning population movements. It is supposed that the Coastal Plain Province once supported a nomadic hunting population up to about the first quarter of the nineteenth century, when the scarcity of game forced them to leave that area. The starving survivors joined the coastal peoples, or went south to the Colville River area and its tributaries in the Foothills Province. Stoney met settlements in the mountain area above the Colville River in 1886. Stefansson tells us that this region in the Foothills reportedly could not support a native population in the early twentieth century. The dread epidemic that hit the visiting inlanders at Point Barrow undoubtedly had far-telling effects (Brower, 1942, pp. 228–229). The last chapter to this story of a losing struggle with nature is mutely told by the surviving Killik Eskimos.

There seems to be fairly abundant evidence of precontact Eskimo archeology on the north slope of Alaska, amply demonstrated by finds of chert flakes and artifacts and habitation remains. Material remains of pre-Eskimo origins have been discovered farther to the west of the Colville basin area (Thompson, 1948; Solecki, in press). It is to be presumed that pre-Eskimo data may be found in the central and eastern parts of northern Arctic Alaska in the future. Although the archeological evidence from the interior as represented here is sketchy, there seem to be no immediate grounds for supposing that the Nunatagmiut were descendents of the original Eskimo.

FUTURE ARCHEOLOGICAL INVESTIGATIONS

The program for future archeological investigations on the north slope may be concerned with several questions: (1) What is the extent of pre-Eskimo remains and distributions in reference to the Folsom point reported on by Thompson (1948) and the Mongolian polyhedral cores with associated material found by the writer in 1949 (Solecki, in press; 1950)? (2) Were there different contemporary prehistoric cultural groups inhabiting the north slope? (3) What was the origin of the Colville basin and mountain Eskimos—were they relatively late comers? (4) Could the retreat of the inland Eskimos and their final dispersion in historic times be ascertained by archeological means? (5) What were the relationships between coastal and interior Eskimo groups (Collins, 1943, p. 220)? (6) Were the inland Eskimo of the north slope more numerous than the coastal Eskimo in the aboriginal period (Larsen and Rainey, 1948, p. 24)?

These are a few of the more obvious questions that come to mind. As common with many problems, the investigation of one opens a host of others to enquiry and this certainly can be anticipated in future archeological research in northern Alaska.

APPENDIX

THE SITES

1. Two gray-green chert flakes and 10 black chert flakes were found on a ridge site 1 mile west of Kuna River. The area of the finds contained about 50 feet square. It was apparently a lookout station.

2. A lookout station was discovered on a ridge one mile from the Kuna River on the east side. Chert flakes and scrapers were recovered from a 100-yard elongate area parallel to the river. The specimens consisted of about 9 black chert flakes, 5 gray-green chert flakes, 1 dark gray chert flake, 1 light gray chert flake, 1 large broken worked gray-green chert flake, 1 red chert flake, and 1 gray-green chert flake, both of the latter showing use-retouch.

3. A recent camp site was found about 4 or 5 miles from the Kuna River on the west side. The evidence was camp debris consisting of caribou bones, tin cans, and willow bundles. One stone "ring" about 8 to 10 feet in diameter was associated with these remains on a hill top. There were many ridge markers leading up to this site and past it.

4. On a bluff and ridge overlooking the Kuna River from the east bank was found a lookout station, evidenced by chert artifacts and debris. This material was found in a 50 square yard area. Nine black chert flakes, 7 gray-green chert flakes, 4 gray-green chert flakes showing use-retouch, 1 gray chert scraper, and a fragment of a black chert blade were recovered.

5. About 8 miles back on Fay Creek, a tributary of the Etiviluk River, was found an Eskimo site consisting of 2 tent (?) rings of stone on a ridge top. No artifacts were discovered, but several broken animal bones and some broken willow branches were observed. This material seemed to be of recent origin, dating within the last 20 years at least.

6. One mile away from the Etiviluk River on the east side the geologists noted one stone ring, evidently a camp site. No other indications were seen.

7. Lower down on the Etiviluk River about 3 miles back on the east side and one-half mile from a lake was found a site measuring 30 yards square on a little knoll. This site yielded 65 dark gray chert flakes, 1 point end of a gray chert blade, 1 point end of a gray chert projectile point, and some well-decomposed fragments of bone. Many more sites were observed on the lower Etiviluk River, but no record was kept of them by the geologists. No additional finds of stone working industry were made on the river lower down.

8. Howard in 1886 reported a thriving inland Eskimo village (Tooloouk) in the general vicinity of the junction of the Nigu and Etiviluk Rivers.

9. A nodule of black chert and a fragment of a stemmed black chert projectile point were found on the east side of Nigu River. Other details of the discovery are lacking.

10. Evidence of a recent overnight camp consisting of some decomposed willow branches was found on the north side of the Colville River. Some trial markers were seen nearby.

11. Howard reported a village site (E-tiv-o-li-par) at the junction of the Etiviluk and Colville Rivers, apparently not far from site 10 on the same side of the Colville.

12. Twelve fairly recent Eskimo camp sites were found on the upper Killik River. The evidence, scattered broadcast, included cut willow boughs, tin cans, caribou skins, and mountain sheep and caribou heads. The geologists also found tent stakes outlining at least 8 to 10 tents. An old wooden boat was discovered amount the willow clumps in this area.

13. On a middle fork of the Okpikrurak River was found a recently abandoned camp consisting of 8 huts covered with caribou hides. There were willow frames or huts floored with brush covered stones. Many drying racks, and animal remains representing foxes, wolverines, caribou, and moose were noted. Empty cartridge cases, tin cans, discarded skin clothing and mukluks were found scattered about. At least 30 or 40 individuals probably occupied this camp.

14. Stones piled up around in a circle as for a blind were found on a ridge lookout on Fortress Creek, a tributary of the Ayiyak River.

15. A popular recent camp site was encountered on a gravel bar on the west bank of the Ayiyak River. The site was situated in a big willow grove. There was much camp debris littering the neighborhood, including boat stays and strips of sheet metal. Game was especially abundant in the locale. This area seems to have been particularly favored by moose.

16. A recent native camp site was found on the west side of the Okokmilaga River. No other details were given.

17. Several old camp sites were found on the east side of the Okokmilaga River, about 5 miles

south of the Brooks Range front, within the mountains. Fifty old-appearing, lichen covered stone cairns were found on a terrace overlooking the valley at the foot of a big mountain.

18. A recent Eskimo camp site was found on the right bank of the upper Okokmilaga River. This camp site seems to have been a main inland Eskimo rendezvous between Killik and Anaktuvuk Passes. There was evidence that children played games there.

19. Several weathered rings of stone were found on the divide of a ridge top.

20. A recent Eskimo camp site was located near the head of the Kiruktagiak River. Evidence was found indicating that the natives had used oil shales for fuel.[18] This material has fairly good burning qualities.

21. Chandler Lake was a favorite native resort. A camp site was situated at the lower part of the lake near a creek. There were recent graves among older ones, marked with crosses. Possible sites were reported on glacial moraines near Big and Little Chandler Lakes. There was a local supply of chert in the mountains, where cherty inclusions were to be found in the limestone.

22. Tin cans and other recent debris marked a native camp site on the east side of the Kiruktagiak River.

23. Two stone "rings" and some old willow boughs were observed up on a ridge top west of the Kiruktagiak River.

24. Several fragments of bone and some charcoal were discovered on a gravel bar of Anak Creek, a tributary of Maybe Creek. This evidence could have been transported and redeposited by stream action, according to the geologists.

25. Several chert flakes, scattered on two locations, were collected on a high ridge top above Maybe Creek.

26. Four black chert flakes were recovered on Red Hill, a good lookout station two miles to the northwest of Umiat.

27. Some old hut willow frames were noted on the Kutchik River. The site overlooked a broad valley.

28. A camp site was found on a little knoll on the southwest corner of Kanayut Lake, in a glaciated valley. It was situated near the mouth of a small stream. The evidence consisted of one tent stake of sharpened antler and a stone ring or circle of stones 6 or 7 feet in diameter. Scattered stones representing a possible camp site was observed on the opposite side of the lake. Additional occupational evidence was recovered in the area in the form of antler tent stakes, and a fairly new nickled-steel trap. Kanayut Lake (formerly Willow Lake) is the largest lake in the central part of the Brooks Range.

29. Three Eskimo camp sites are situated near the head of Nanushuk Lake. These sites are represented by three stone circles or house rings, approximately 6 feet in diameter. One of the houses had a depression in the center 12 to 14 inches deep and 2 feet in diameter. Apparently these remains were not recent, since they were covered with tundra and willows were growing from the depression.

30. E. J. Webber, formerly with the U. S. Geological Survey, found two long, narrow projectile points with side notched bases of green chert on a camp site near the Nanushuk River. These specimens are presumably in the finder's possession.

31. A large recent Eskimo camp site was reported on the east side of Itkillik Lake. From 20 to 30 hut remains were noted on a 200-yard stretch along the lake. The occupational evidence includes an iron ax, a wooden bow, wood net floats, tent stakes, empty nail kegs, shoe pacs, tin cans, khaki trousers (no skin clothing), pieces of string, hundreds of saw-cut caribou skulls and bones, and an abundance of willow boughs. This was an extremely good camp location, since there were plenty of caribou in the nearby area, and the willow clumps grew to about 6 or 7 feet high near the creek. There is good fishing in the lake, with grayling and trout from 30 to 32 inches long.

32. The rotted remains of a sled were observed on a camp site at a stream junction of the Sagavanirktok River. A fallen cross, probably that of a grave was also seen, although no evidence of burial was found. There were indications of a prospector habitation or marker farther up the river.

33. One windbreak or hunter's blind[19] of

[18] Howard (*in* Stoney, 1900, p. 69) on his journey down the Etiviluk noted that the native Eskimos were using shale (presumably oil shale) for fuel.

[19] Stefansson (1914, p. 211) found what appears to have been similar constructions on about every "fifth hill or so set up by man" at Cape Parry. He specifically mentions a half circular wall of stones about 10 or 12 feet in diameter. The stones weighed about 300 or 400 pounds apiece.

sandstone prominently situated on a ridge top was noted on the west side of the Shaviovik River. Associated with this structure were several .44-caliber cartridge shells. Evidences of excavation for iron ore was found nearby.

34, 35, 36. Windbreaks or hunter's blinds were discovered on high prominent ridges west of the Shaviovik River. These structures were constructed of sandstone. There were two conspicuous blinds on the ends of the ridges.

37. Debris of a recent Eskimo camp littered an area on the east side of the Shaviovik River. Bear skulls, tin cans, and discarded clothing made up part of the refuse.

38. A recent Eskimo encampment marked by tin cans, caribou skulls, and coffee cans was located by the geologists on the upper central Shaviovik River.

39. Four or five hunting blinds of stone were found erected on a ridge top above the Canning River on the west side.

40. Several recent Eskimo camp sites were noted on the Canning River at Shublik Spring. The latter is an open spring. The camp remains included mountain sheep bones and skulls, coffee cans, and the wooden boom of a sail boat.

41. Remains of a fish net discovered on the shore of Schrader Lake points to native occupancy there. No other evidence was noted.

42. Evidences of recent and old Eskimo occupations were observed by Dr. George Llano, of the Department of Botany, U. S. National Museum. He recovered an Eskimo crooked knife, an antler projectile point, and a small wooden toggle from this site.

THE ARTIFACTS

The Nonlithic Material

Recent Eskimo material was brought back by Arthur Bowsher,[20] one of the leaders of the Geological Survey parties. Mr. Bowsher found the following specimens at Itkillik Lake (site 31). The items (Fig. 4) described below were all surface finds.

1. One crudely fashioned although still serviceable iron ax with a wooden handle. The head, which is not very rusted, has an expanded blade, which has been resharpened recently. The handle is 55 cm long. The opposite end has also been inserted into the ax head hole. There are 7 holes about 0.5 cm in diameter through the flat part of the handle. It may have been part of a sled runner. (Fig. 4, *a*.)

2. A net sinker float of light wood, 8 cm long and 5.3 cm in diameter across the flat ends. There are two holes for suspension on the net, one at each end of the float. The holes are on the same axis and are bored in from the sides at an angle. (Fig. 4, *b*.)

3. One saw-cut caribou tent stake 29 cm long. The antler is divided lengthwise by a saw cut. The point is saw-sharpened. (Fig. 4, *f*.)

4. One saw-cut caribou antler 41.5 cm long. There is a slot at the distal end, 3 cm deep and 1.5 cm. wide. There is a constriction below the slot which probably facilitated hafting. (Fig. 4, *g*.)

5. Half of a willow bow, 55 cm long. The bow is curved and has a nock for the bow string on the distal end. It is broken at the handle. (Fig. 4, *h*.)

Dr. Llano recovered three specimens at Anaktuvuk Pass (site 42). These items (Fig. 4), described below, were found on the surface.

1. An antler projectile point 11 cm long and 0.7 cm thick. It is slightly curved and pointed at both ends. The tang of this arrowhead is encircled by a projecting ring, similar to that illustrated for Tigara by Larsen and Rainey (1949, fig. 51d). This is but slightly different from the modern type point. (Fig. 4, *c*.)

2. A wooden toggle 9.5 cm long and 1.1 cm thick, well fashioned and smoothed. There are rounded knobs at both ends formed by cutting away part of the stock. (Fig. 4, *d*.)

3. One carved antler handle of an Eskimo crooked knife 34 cm long. An iron blade had apparently been fastened at the distal end. There are four holes drilled through the handle. (Fig. 4, *e*.)

All the above artifacts are undoubtedly of recent Eskimo origin. It is difficult to determine from the condition of these pieces themselves how old they might be, since material does not seem to deteriorate in the Arctic as rapidly as in more temperate climatic zones. The evidence of saw cuts, knife cuts, etc., certainly points to post-White contact origins.

The Illustrated Lithic Material

The illustrated lithic specimens (Fig. 4) are typical of the entire lot available to the author for examination. Four sites are represented in

[20] Now of the Department of Geology, U. S. National Museum.

the following order: Site no. 2 (*i*); no. 4 (*k*, *l*, *m*, *n*); no. 7 (*o*, *p*); no. 9 (*i*, *q*).

1. A long specimen of light greenish chert (Fig. 4, *i*) appears at first glance to be merely a reject. However, it seems to be a unique reject. The face shown in the illustration exhibits primary percussion flaking, the longest side exhibiting secondary chipping. This latter feature is ap-

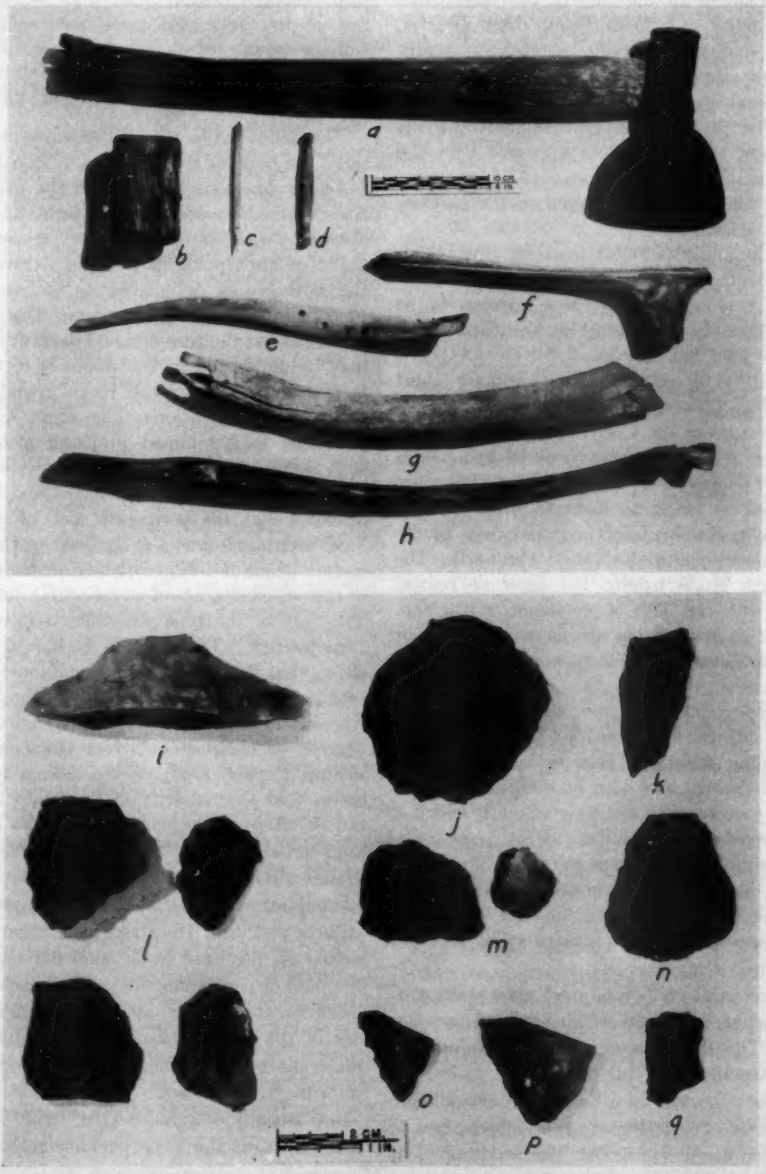

FIG. 4.—Artifacts from interior Alaska. Nonlithic material: *a*, ax; *b*, net float; *c*, antler arrowpoint; *d*, wooden toggle; *e*, handle of crooked knife; *f*, tent stake; *g*, hafted antler; *h*, piece of bow. Lithic material: *i*, Worked reject; *j*, nodule; *k*, reject blade fragment; *l*, ordinary flakes; *m*, use-retouched flakes; *n*, end scraper; *o*, *p*, point ends of projectile point and blade; *q*, midsection of projectile point.

parently derived from use-retouch. The specimen is quite thick for its proportions near this edge, or 2.8 cm at the greatest thickness. It presents a flat surface on the underside almost at right angles to the axis of the face plane.

2. A reject nodule of black chert (Fig. 4, *j*). The ends were heavily battered by poorly controlled percussion blows from all sides. This is evidenced by the flake surfaces and the bulbar scars. The specimen is approximately 2.2 cm in average thickness. It is apparent that the flakes did not carry well across the specimen, bringing about obdurate knobs on the surfaces of the specimen.

3. A fragment of reject material (Fig. 4, *k*). It is evidently part of a broken blade quite thick-bodied in cross section. There appears to be some secondary retouching on the edge which indicates poor flaking control.

4. This is a group of four ordinary chert flakes (Fig. 4, *l*) typical of the percussion-struck variety found in the Colville Basin area. These flakes are universally common on workshop sites even to comparatively recent times. They are illustrated in order to indicate what type of common workshop debris material may be expected on chipping stations in the north. The two upper flakes exhibit the inner or ventral surface with the bulb of percussion at the top. On the two lower flakes are shown the outer or dorsal surfaces with the characteristic oblique flake beds.

5. Two examples of chert flakes (Fig. 4, *m*), which evidently had been used for some cutting or scraping function. The perimetrical edges, originally sharp, had been blunted and chipped in this process. The resulting effect is called a "use-retouched" flake.

6. A simple flat end-scraper of dark gray chert (Fig. 4, *n*). It shows some pressure flaking and use-retouch on the lower, broader end. This specimen was originally a large spawl adapted for use as a scraper.

7. The point end of a broad gray chert projectile point (Fig. 4, *o*) which has been pressure flaked. The flaking shows poor control of the technique.

8. The point end of a broad gray chert blade or projectile point (Fig. 4, *p*) which appears to have been percussion flaked. The resulting effect is clumsy in shape and finish.

9. This is the midsection of a modern type, pressure flaked, stemmed, long and narrow black chert projectile point (Fig. 4, *q*). It exhibits well-controlled pressure flaking, which was carried at right angles to the parallel sides of the artifact. The excellent quality of the workmanship contrasts sharply with that found on the rest of the lithic specimens recovered in the Colville basin.

Discussion of the Lithic Material

The flaked artifacts and the waste stone material are of local cherts, probably derived from Lisburne limestone occurring in the mountains. An examination of these artifacts and flakes discloses (with the exception of one specimen) that they are typologically similar to those which the author has designated as Colville Basin Phase material (Solecki, in press). The identical materials and the chipping and flaking technique may be duplicated on the majority of the artifacts from the Kukpowruk, Kokolik, and Utukok River chipping stations. The single exception, a broken long-stemmed projectile point (Fig. 4, *q*), exhibits expert controlled pressure flaking.

An examination of these flakes and artifacts discloses that the percussion method seems to have been used almost exclusively in the manufacture. None of the flakes, which are the majority of the specimens, are of any singular distinction. They are of the type sometimes referred to as "nondescript." Examination of the flake faces shows that the blank was not juxtaposed in any set manner to receive the blows of the hammer. Apparently the blows were directed from varying degrees of obliqueness across the face of the nodule. Further study of the flaking technique shows that the majority of the flakes had been struck off from the core or blank at an angle approximating 120°. This angular measurement is determined by measuring the angle between the axis of the flake plane and the axis of the striking platform. The striking platform is represented on the flake by a small flat area above the bulb of percussion where the detaching blow had been struck. This apparently again exhibits one of the limitations of the manipulability of materials with conchoidal fracture, which falls in with N. C. Nelson's studies (1938, p. 158). More recently Watanabe (1948) has illustrated and described the same phenomena in Japan.[21]

[21] The writer is indebted to Ferdinand Okada, of the Department of Anthropology, Columbia University, for the translation of Watanabe's article.

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BIOLOGY.—*A consideration of mineral nutrition of boxwood in relation to infection by meadow nematodes,* Pratylenchus spp.[1] A. C. TARJAN, University of Maryland. (Communicated by G. STEINER.)

Plant nematology is a comparatively recent science. To date, most of the investigations in this field have been concerned mainly with a study of the pathogenic nematodes, the diseases they cause, and possible means of control of these diseases. A few German workers (*9*, *15*, *17*) have conducted chemical analyses of infected plant parts, but these have been principally on plants infected by the sugar-beet nematode, *Heterodera schachtii* Schmidt, while most of the other nematode-induced plant diseases have not yet been studied as to mineral requirements of the plant hosts.

Certain meadow nematodes, members of the genus *Pratylenchus* attacking the roots of boxwoods, can cause a pronounced decline of these plants (*13*). Symptoms appearing on the above-ground parts are described as an

[1] Division of Plant Pathology, University of Maryland, Paper no. 95. Contribution no. 2203 of the Maryland Agricultural Experiment Station. Received February 3, 1950.

unhealthy appearance of the plants resulting from partial to almost complete defoliation, unnatural reddening or chlorosis of the leaves, and stunted growth. An inspection of the root system shows a dwarfed bushy type of growth with a pronounced absence of deep feeding roots. A close observation will reveal brown to black lesions, which usually girdle the roots and eventually cause a sloughing off of the cortical tissues, leaving the fibrous vascular cylinder exposed. It is therefore quite apparent that any plant thus impaired can not long survive without soon indicating in the above-ground parts the deteriorated condition of the root system. Similar symptoms have been observed in the case of other plant nematode diseases. Shaw (*11*) states that the foliage of beet plants, whose roots are invaded by the sugar beet nematode, assumes a lighter green color than normal, with subsequent more severe discoloration of the foliage and death of the plant. Infected plants appear to have an abnormally large number of lateral rootlets. These observations parallel those of Tyler (*14*) who worked with the root-knot nematode, Cobb (*4*) who investigated the activities of the burrowing nematode, *Tylenchus similis* Cobb, and Steiner (*12*) who described symptoms caused by various members of the genus *Pratylenchus* on several types of plants.

On the basis of the symptoms on boxwood foliage described above, it may be suspected that infected plants are suffering from deficiencies of essential elements. The American Plant Food Council (*1*) states that nitrogen deficiency causes a sickly, yellow-green color with a slow, dwarfed mode of growth of the plant. Potash deficiency manifests itself in a mottling, spotting, or streaking of the leaves, while magnesium deficiency results in a loss of green color with definite and sharply defined yellowish-green streaks throughout the leaf. Almost all these symptoms are noticeable in the early stages of the boxwood nematode disease. Kramer and Schrader (*6*) found, in a study on the deficiency symptoms on the Cabot variety of *Vaccinium corymbosum* L., that a magnesium deficiency caused one sharply defined symptom in particular: the leaf margins became chlorotic while the tissue near the midrib remained green. A secondary stage of the deficiency resulted in the chlorotic areas turning red and necrotic. A similar condition is found in infected boxwood leaves and has been, in the past, attributed to either drought or winter injury. In a series of tests by Keyes (*5*) on *Gardenia veitchii* Hort., it was found that a potassium deficiency caused chlorosis of the leaves as well as a cessation of growth; further, that calcium deficiency resulted in a breakdown of root tissue starting at the tips of the roots. New roots were not produced and as the disintegration of the root system progressed, wilting occurred. Although in nematode-infected boxwood roots there occurs a breakdown of the roots inhabited by nematode colonies, this has been attributed to the destruction of the cortical tissues by the nemas which are usually situated between the healthy and deteriorating portions of the rootlet.

Vaňha (*15*) analysed the dry matter of the roots of nematode-infected sugar beets and found lower percentages of phosphorus, magnesium, and calcium and a decidedly lower percentage of potassium in the infected roots in contrast to the healthy. Wilfarth and Wimmer (*17*) likewise found that infected sugar beets had lower percentages of nitrogen, potassium, sodium, calcium, and magnesium. They concluded that the plants were deprived of nutritional substances due to the presence of the nematodes, and stipulated that an abundant potassium fertilization would maintain the proper sugar content within the beets but would not prevent a lowering of the yield. They assumed that proper yields could be maintained only by a comprehensive and abundant fertilization program. Roemer (*9*), however, was able to increase the yield of nematode-infected sugar beets from 18,000 to 19,000 kg per 2.47 acres by applying only a potassium fertilizer.

It can therefore be seen that in the case of certain plant nematode diseases there is a marked reduction in certain of the nutritional elements contained in the plants. The present investigations were undertaken with the objective of correlating the disease symptoms expressed by boxwood plants infected by meadow nematodes with a possible excess or deficiency in the amounts of some of the elements required for normal growth by the plants.

MATERIALS AND METHODS[2]

A total of 48 6-month-old dwarf English boxwoods, *Buxus sempervirens* var. *suffruticosa* L., which had been rooted and grown under comparable conditions, were transplanted into a potting medium of approximately one-third sand and two-thirds soil in 5-inch pots. These were separated into two groups of 24 plants each. One and one-half grams of finely chopped, healthy boxwood roots were incorporated into the soil in each pot in one group, while 1½ grams of finely chopped meadow nematode-infected boxwood roots were applied to the soil in each pot in the other group.

After six months of growth, all plants were washed and weighed. The mean weight per plant in each group is presented in Table 1. The plants were then dried for 48 hours at approximately 125°F. The 24 plants in each group were then separated into six lots of four plants each, and each lot was further separated into stem, leaf, and root samples. These were ground in a Wiley Mill equipped with a 60-mesh wire screen.

Ash solutions were prepared and analyzed for nitrogen, phosphorus, and magnesium by methods suggested by Lindner (*7*). In the preparation of reagents for the determination of nitrogen, Nessler's solution was prepared according to Vanselow (*16*).

Potassium, sodium, and calcium readings were obtained by use of the Beckman flame spectrophotometer.

Boron was determined by the same methods proposed by Berger and Truog (*2*, *3*) except that the color comparisons were made by use of a Coleman spectrophotometer at a wavelength of 610 millimicrons (*10*).

TABLE 1.—WEIGHT COMPARISONS BETWEEN HEALTHY AND MEADOW NEMATODE-INFECTED BOXWOODS.

	Healthy	Diseased
Weight in grams	18.6* ± 1.2	14.6† ± 0.7

*L.S.D. at the 1-percent level is 2.6.
†Each value represents the mean of 24 replicate plants.

RESULTS

As can be seen in Table 2, the amount of calcium in the diseased stem, leaf, and root samples was higher than in the healthy samples. This is contrary to the results of Vaňha (*15*) and Wilfarth and Wimmer (*17*), who found, in working with sugar beets infected with the sugar-beet nematode, that there was a lower amount of calcium in the diseased tissues than in the healthy.

The differences in boron content between healthy and diseased samples were insignificant.

Magnesium was higher in healthy stems, diseased leaves, and healthy roots. Other investigators (*15*, *17*) had not found differences in magnesium (in oxide form) to be very great in analysis of healthy and diseased sugar beet plant parts.

Sodium was higher in diseased stem and leaf samples while in root samples it was higher at the 1-percent level of significance.

Nitrogen was higher in healthy stem and leaf samples while in root samples it was

[2]The author expresses sincere appreciation to Dr. L. E. Scott, Department of Horticulture, University of Maryland, for his valuable suggestions, guidance, and criticisms during the execution of the chemical determinations involved.

TABLE 2.—MINERAL CONTENT OF HEALTHY AND DISEASED BOXWOODS EXPRESSED IN MILLIGRAMS PER GRAM OF OVEN-DRY SAMPLE

Mineral	Stems		Leaves		Roots	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
Boron	0.005* ± 0.002	0.007 ± 0.002	0.036 ± 0.006	0.043 ± 0.008	0.002 ± 0.001	0.007 ± 0.005
Calcium	0.48 ± 0.13	0.83 ± 0.15	1.53 ± 0.11	1.88 ± 0.18	0.35 ± 0.05	1.02 ± 0.16
Magnesium	5.83 ± 0.88	4.92 ± 1.00	15.67 ± 0.38	16.75 ± 0.79	7.42 ± 0.93	6.08 ± 0.79
Nitrogen	22.60 ± 2.55	21.10 ± 0.54	41.50 ± 0.74	40.20 ± 0.69	37.20 ± 1.39	47.60† ± 1.67
Phosphorus	1.50 ± 0.22	1.70 ± 0.16	2.70 ± 0.10	3.70† ± 0.27	2.80 ± 0.26	3.20 ± 0.14
Potassium	2.10 ± 0.03	2.07 ± 0.14	5.43† ± 0.32	1.88 ± 0.18	5.00† ± 0.18	3.33 ± 0.11
Sodium	0.50 ± 0.07	0.82 ± 0.54	0.68 ± 0.05	0.82 ± 0.05	0.48 ± 0.05	1.63† ± 0.16

*Each value represents the mean of six composite samples.
†Significant at odds of 99 to 1.

significantly higher at the 1-percent level in diseased samples as compared to healthy samples.

Phosphorus, as in the case of nitrogen, was higher in diseased stem and root samples than in healthy samples and was significantly higher at the 1-percent level in diseased leaves than in healthy leaves.

Potassium in healthy stem samples was higher than in diseased stem samples, while it was significantly higher at the 1-percent level in both the leaf and root samples as compared to the diseased.

DISCUSSION

The results presented above appear to be due to the deleterious effects of feeding of meadow nematodes on the roots of box wood plants. It may be that the gradual rotting away of the root system due to the nematodes is cardinal in instigating the decline and eventual death of the plants, but here one would assume a proportionate decrease in the level of all minerals contained in the stems and leaves rather than a decrease in some and an increase in others as occurred. Then too, one should not preclude the fact that secondary invaders, which are in constant association with the nematodes, may be the real pathogens which cause the decline of these plants. Since Koch's postulates can not be proved for this disease, as well as for diseases caused by viruses or by other obligate parasites, we can not definitely assert that the meadow nematode is the primary cause of decline in boxwood, but must be content with stating that this nematode is almost constantly associated with this disease.

Another very important possible cause of decline in boxwood is brought to light by the work of Linford (*8*) who found that various types of nematodes, such as *Aphelenchoides* spp., *Ditylenchus* spp., and *Aphelenchus* spp., have esophageal glands that are salivary in nature. He observed that the above-named nemas ejected fluid from their esophageal glands into the root tissues of the host while feeding. These fluids, which are strongly digestive in nature, functioned in the breaking down and digestion of the tissues and were then sucked back into the nematode body. Linford concluded that "destructiveness may be closely related to the volume and composition of the saliva injected into the tissues, rather than to the ability of the parasite to destroy tissue by mechanical means." Following Linford's reasoning, we find that inspection of the meadow nematode microscopically reveals three rather large esophageal glands, which undoubtedly play an important role in the feeding of this parasite. It may actually be then that the symptoms of this disease are, for the most part, a response of the plant to the esophageal secretions ejected by the nematodes, and that these secretions are toxic to the plant.

In view of the above findings, a method is suggested of possibly alleviating the effects of this disease and allowing the affected plants to regain, at least in part, some of their former vigor. Infected boxwoods could be given fertilizers containing relatively heavy concentrations of potassium and low concentrations of sodium, nitrogen, and phosphorus. These materials could either be broadcast directly on the soil, applied to the soil as a liquid fertilizer, or injected into the plants. In theory, the restoration of the normal balance of mineral nutrients in the plant would promote a refunctioning of the normal plant metabolism, and new plant parts would eventually be produced. This might improve the appearance of the plants considerably but would not necessarily indicate that they were becoming immune to the effects of feeding by the nematodes. Rather, it would add to the life of the plants, and possibly insure their successful competition with the nematodes until some effective methods of control were devised.

SUMMARY

Mineral analyses for boron, calcium, magnesium, nitrogen, phosphorus, potassium, and sodium were conducted using stems, leaves, and roots of healthy and meadow nematode-infected dwarf English boxwoods, *Buxus sempervirens* var. *suffruticosa*. It was found that roots of infected plants contained higher levels of sodium and of nitrogen whereas the roots of healthy plants contained a higher level of potassium. Leaves of infected plants contained a higher level of phosphorus, while leaves of healthy plants contained a higher level of potassium.

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ENTOMOLOGY.—*A new genus and three new species of Microlepidoptera from California (Ethmiidae)*.[1] J. F. GATES CLARKE, Bureau of Entomology and Plant Quarantine.

The following new species and new genus are described to provide names to correspondents and to continue the arrangement and development of the National Collection.

Ethmia nadia, n. sp.

Figs. 1-1a

Alar expanse, 20–22 mm.

Labial palpus sooty black; basal segment heavily white scaled, second segment sparsely so and a narrow apical white annulus and the third segment white scaled above. Antenna sooty black with sparse white scaling on scape basally. Head sooty black with white scaling between the antennae and laterally. Thorax sordid white with four sooty-black spots placed one on each side, one anteriorly and one posteriorly; tegula sordid white with a black spot basally. Fore and hind wings blackish brown, cilia concolorous; forewing with a longitudinal white streak extending from base to end of cell where it forks, the scaling bordering the fork, black; the costal edge of the longitudinal streak narrowly edged with black, the dorsal portion overlaid with gray; at basal fifth, in the longitudinal streak, a black spot; around termen a series of indistinct black spots. Forelegs and midlegs blackish brown; hindlegs ocherous. Abdomen, except blackish brown first segment, orange-ocherous.

Male genitalia.—As figured. The posterior edge of gnathos with a strong comb of teeth; anterior portion with strongly sclerotized lateral teeth.

Female genitalia.—Female unknown.

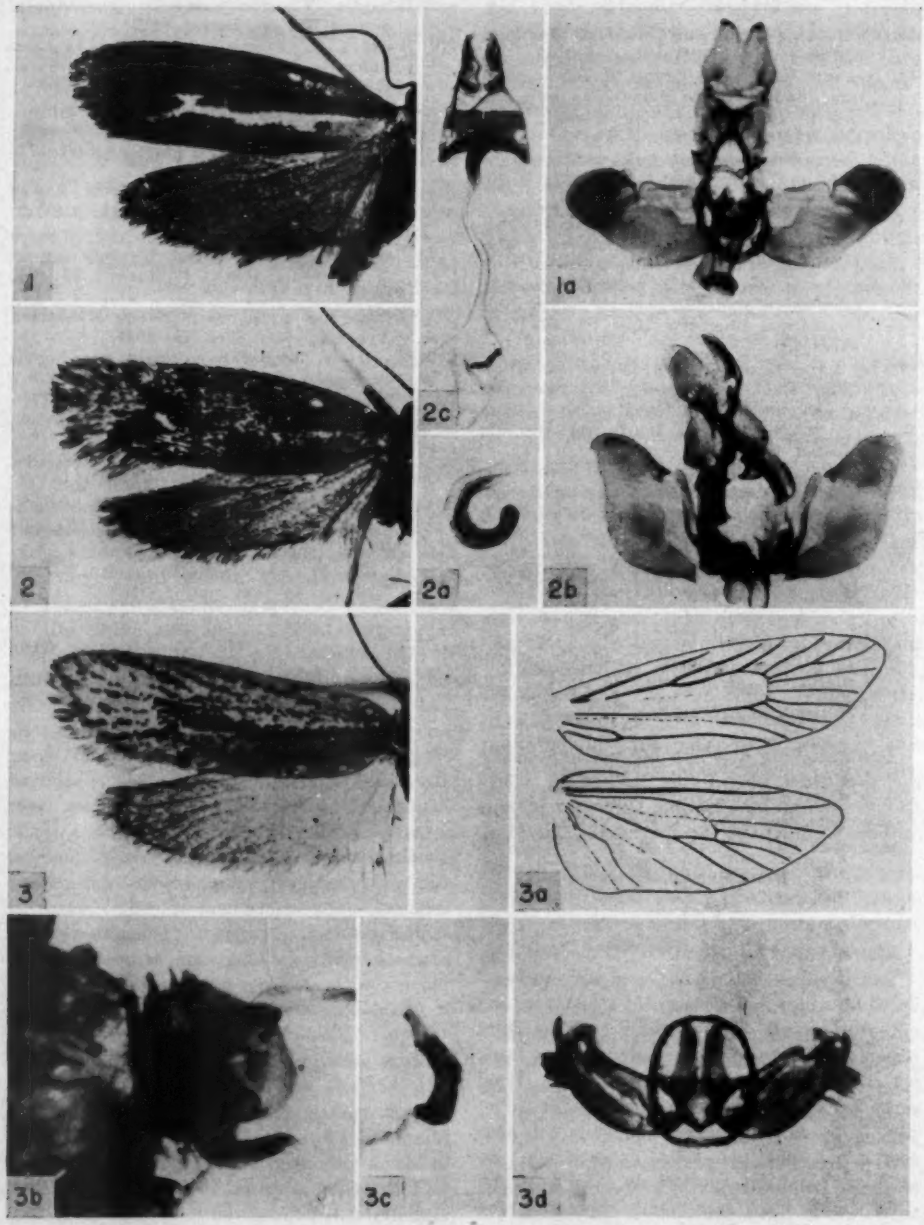
Type.—U.S.N.M. no. 59367.

Type locality.—McCloud, Calif.

Remarks.—Described from the type ♂ and two ♂ paratypes, all from the same locality (June 5, 1935, E. C. Johnston). Both paratypes in Mr. Johnston's collection.

This species is nearest to *E. albistrigella* (Walsingham) but differs from it by the wider basal portion of the longitudinal streak of the forewing and by the presence of the black spot, in the white streak, at basal fifth. The anterior portion of the gnathos of *albistrigella* is studded with small teeth which are absent in *nadia*.

[1] Received March 14, 1950.



FIGS. 1-1a.—*Ethmia nadia*, n. sp.: 1, Left wings; 1a, ventral view of male genitalia with aedeagus in situ. FIGS. 2-2c.—*Ethmia brevistriga*, n. sp.: 2, Left wings; 2a, aedeagus, lateral aspect; 2b, ventral view of male genitalia with aedeagus removed; 2c, ventral view of female genitalia. FIGS. 3-3d. *Pseudethmia protuberans*, n. gen., n. sp.: 3, Left wings; 3a, venation of right wings; 3b, lateral aspect of head to show palpus and protruding frons; 3c, aedeagus, lateral aspect; 3d, ventral view of male genitalia with aedeagus removed.

Ethmia brevistriga, n. sp.

Figs. 2-2c

Alar expanse, 13–14 mm.

Labial palpus blackish brown, basal segment heavily overlaid with white, second and third segments sparsely irrorate with white. Antenna, head, thorax, and forewing blackish brown; head white scaled posterolaterally; tegula white distally; forewing irrorate with white, heavily so before tornus and apically; from base of wing a very narrow, white streak extends along fold to about two-fifths; at the end of cell is a conspicuous white oblique oval spot; cilia fuscous mixed with white. Hindwing fuscous with a slight brassy hue; cilia whitish fuscous with a fuscous basal band. Legs blackish brown except posterior tibia and tarsus, which are whitish fuscous. Abdomen blackish brown, tipped posteriorly with ocherous white and sparsely irrorate with white beneath.

Male genitalia.—As figured. Anterior portion of gnathos consisting of two divergent lobes, excavated on their inner surfaces.

Female genitalia.—As figured. On right side of ductus bursae, just before ostium, there is a small evagination. Signum a narrow dentate plate.

Type.—U. S. N. M. no. 59368.

Type locality.—Bodega Bay, Calif.

Remarks.—Described from the type ♂ and two ♀ paratypes all from the same locality (May 2, 1937, E. C. Johnston). The type and one ♀ paratype are in the U. S. National Museum and one paratype is in Mr. Johnston's collection.

This species falls in the *albitogata* group but lacks the light hindwing.

Pseudethmia, n. gen.

Figs. 3-3d

Typus generis.—Pseudethmia protuberans, n. sp.

Head with posterior ridge, frons a prominent, rounded protuberance clothed with short, compact scales; dorsal surface of head smooth scaled except for small, lateral tufts of spreading scales above eye. Antenna simple, without pecten from scape. Labial palpus short, reaching slightly beyond lower edge of frons; second segment slightly longer than first; third segment about one-fourth the length of second, porrect. Tongue well developed.

Forewing elongate, ovate, costa nearly straight, 12 veins; 1b furcate, 1c strongly preserved, 2 from near angle; 7 and 8 stalked, both to costa; 11 from middle.

Hindwing slightly broader than forewing, 8 veins; 2 distant from 3, 3 and 4 connate or short stalked, 6 and 7 parallel basally, divergent distally; discocellulars inwardly oblique between 5 and 7.

Male genitalia.—Symmetrical; harpe roughly oval, clasper absent. Anellus with lateral processes. Uncus, socii and gnathos absent.

Female genitalia.—Female unknown.

This genus is nearest *Ethmia* Hübner but easily differentiated from it by the short palpus, protruding frons and absence of the uncus and gnathos.

Pseudethmia protuberans, n. sp.

Alar expanse, 18–21 mm.

Labial palpus sordid white, second segment with a blackish fuscous apical annulus. Antenna fuscous more or less overlaid with whitish basally. Head, thorax, and forewing sordid white irrorate with blackish fuscous; thorax with a narrow median fuscous stripe; from base of forewing along fold, thence to end of cell, an irregular blackish-fuscous longitudinal streak; cilia white with a narrow pale fuscous basal band. Hindwing pale whitish fuscous, slightly darker apically; cilia whitish with a narrow, pale fuscous basal band. Legs sordid white, tarsi faintly annulated with pale fuscous. Abdomen sordid ocherous white.

Male genitalia.—As figured. Note comb of modified setae from outer surface of cucullus.

Type.—U.S.N.M. no. 59369.

Type locality.—Dixieland, Imperial County, Calif. (March 1–15, 1922. O. C. Poling).

Remarks.—Described from the type ♂ and seven ♂ paratypes as follows: California, Dixieland, Imperial County, March and April dates, 5 ♂♂; Twentynine Palms (March 18, 1941, George Mansfield), 2 ♂♂.

Paratypes in U. S. National Museum, British Museum (Natural History) and the collection of J. W. Tilden, San Jose, Calif.

ZOOLOGY.—*Synonymy of some native American and introduced millipeds.*[1] H. F. Loomis, Coconut Grove, Fla.

The changes here proposed are the accumulation of several years of study and are presented for the most part in order to clarify obscure points in the classification of American diplopods. My thanks are due C. A. W. Jeekel, Zoologisch Museum, Amsterdam, Holland, who pointed out and suggested my publishing certain of the synonyms.

Prostemmiulus xenops, n. name

A new name for *P. heterops* Loomis (Bull. Mus. Comp. Zool. **80:** 29. 1936), preoccupied by *P. heteropus* Chamberlin (Occ. Pap. Mus. Univ. Michigan, no. 133: 15. 1923).

Genus **Alcimobolus** Loomis

Alcimobolus Loomis, Bull. Mus. Comp. Zool. **80:** 56. 1936.

Chamberlin has indicated (Proc. Acad. Nat. Sci. Philadelphia **99:** 44. 1947) that the genus *Alcimobolus* Loomis is synonymous with his *Cubocricus*, probably on the basis of the simple inner gonopods. Other characters of the gonopods, however, are strikingly different, not only from those of *Cubocricus* but from other related rhinocricids, and are amply sufficient to support generic separation. In *Cubocricus* the anterior plates do not exceed the median plate, but in *Alcimobolus* these plates are narrowed and carried far above the median plate. The posterior plates show an even greater departure from the more or less general form associated with most related genera by being higher and broadly rounded-truncate at the apex, near which the surface is slightly hispid; the latter condition, if not unique in the family, is certainly of rare occurrence.

Genus **Arinolus** Chamberlin

From 1922 to 1931 the writer collected extensively in southern Arizona in the hope of rediscovering three species of *Onychelus* that Cook described from there on females only (Proc. U. S. Nat. Mus. **40:** 157–159. 1911). No species of this genus was found, but two supposedly new species of a related new genus, later described by Chamberlin under the name *Arinolus*, were taken from a number of localities. Both of these species also have been described by Chamberlin, one, *A. torynophor*, as the type of his genus. Specimens of the other species, *A. hopinus*, collected by W. M. Wheeler at Tucson, November 21, 1910, and by the writer in the Baboquivari and Santa Rita Mountains, agree with Chamberlin's description of this species and also with Cook's description of *Onychelus hospes*, and it is thought that Cook was in error in referring his species to *Onychelus* and that now it should stand as follows:

Arinolus hospes (Cook)

Onychelus hospes Cook, Proc. U. S. Nat. Mus. **40:** 157. 1911.
Arinolus hopinus Chamberlin, Bull. Univ. Utah **31** (11): 12; pl. 2, fig. 16. 1941.

Study of three female specimens in the Museum of Comparative Zoology, collected in the Huachuca Mountains of Arizona by W. M. Wheeler in 1910, and of Cook's descriptions of *Onychelus dentatus* and *O. suturatus*, whose type locality is these mountains, also leads to the conclusion that but one species is involved and that it should be included in the genus *Arinolus* as its largest species.

Arinolus dentatus (Cook)

Onychelus dentatus Cook, Proc. U. S. Nat. Mus. **40:** 158. 1911.
Onychelus suturatus Cook, Proc. U. Nat. Mus. **40:** 159. 1911.

A great many Arizona specimens collected by the writer in the San Tan Mountains (near Sacaton), the Picacho Mountains (between Casa Grande and Tucson), the Superstition Mountains at Fish Creek (the type locality of *A. torynophor*), and between Superior and Miami, have 39 to 44 segments and are 25 to 38 mm long and 2.5 to 3.8 mm in diameter. Chamberlin's descriptions of both *A. torynophor* and *A. apachellus* fit these specimens, and his drawings do not seem to preclude the possibility that but a single species was represented, for the drawings of the inner ("posterior") gonopods are not comparable; that for *torynophor* does not show the important anterior face, and the anterior view of the complete gonopods of this species shows several more separate pieces than occur in any specimen of this family that the writer has seen or than are shown in Chamberlin's drawing of *apachellus*, which appears to have one extra piece at the lower left,

[1] Received January 24, 1950.

the right side of the gonopod not having been illustrated. A drawing of the gonopods of a male from the San Tan Mountains is here included for comparison (Fig. 1).

Arinolus torynophor Chamberlin

Arinolus torynophor Chamberlin, Journ. Ent. and Zool. (Pomona College) **32**: 81. 1940.
Arinolus apachellus Chamberlin, Bull. Univ. Utah **31** (11): 10, pl. 2, figs. 12–14. 1941.

Genus **Pseudospirobolellus** Carl

Pseudospirobolellus Carl, Rev. Suisse Zool., **20**: 168; 1912.
Spirobolellus Attems, Mitt. Nat. Mus. Hamburg **24**: 131. 1907.
Azygobolus Loomis, Smithsonian Misc. Coll. **89** (14): 25. 1934.

Actual comparison of specimens may show that *A. tumidus* Loomis (Smithsonian Misc. Coll. 89 (14): 25. 1934) is a synonym of *P. bulbiferus* (Attems).

Genus **Chondromorpha** Silvestri

Chondromorpha Silvestri, Ann. Soc. Ent. Belg. **41**: 356. 1897.
Dasomus Chamberlin, Proc. Ent. Soc. Washington **43**: 34. 1941.
Xaymacia Loomis, Journ. Washington Acad. Sci. **38**: 187. 1948.

Chondromorpha kelaarti (Humbert)

Polydesmus kelaarti Humbert, Mem. Soc. Geneva **58**: 23, pl. 2, fig. 7. 1866.
Paradesmus kelaarti Pocock, Journ. Bombay Nat. Hist. Soc. **7**: 149, pl. 10, fig. 12. 1892.
Prionopeltis kelaarti Attems, Denkschr. Akad. Wiss. Wien **67**: 358, pl. 5, figs. 99–100. 1898.
Dasomus bicolor Chamberlin, Proc. Ent. Soc. Washington **43**: 34, fig. 4. 1941
Xaymacia granulata Loomis, Journ. Washington Acad. Sci. **38**: 187–188, figs. 3–6. 1949.

Chondrodesmus rodriguezi (Brolemann)

Leptodesmus rodriguezi Brolemann, Mem. Soc. Zool. France **13**: 103, figs. 43–46. 1900.
Dirhabdophallus rodriguezi Pocock, Biologia Centrali-Americana: 164. 1909.
Chondrodesmus nicaraguae Chamberlin, Ent. News **35**: 174, fig. 1924.

It is thought that *C. nicaraguae*, which may or may not have come from Nicaragua, although collected at New York City from a shipment of bananas from that country, actually is a synonym of Brolemann's *rodriguezi*. Pocock's figure of the gonopods of *C. spatulatus* (*loc. cit.*: pl. 12, fig. 6c. 1909) does not show the crest mentioned by Chamberlin in his description of *nicaraguae* but such a crest is shown in Pocock's figure for *C. granosus*, just above that of *C. spatulatus*. Brolemann's figure, cited above, shows the crest mentioned and figured by Chamberlin.

Genus **Docodesmus** Cook

Docodesmus Cook, Brandtia, fasc. 2: 5. 1896
Schizodira Loomis, Psyche **48**: 37–38. 1941.

An examination of Bollman's paratype female of *Stenonia maculata* (Proc. U. S. Nat. Mus. **11**: 336. 1888), recently found in the U. S. National Museum collection by R. L. Hoffman, settles several points that have long been in doubt. The family position of this milliped was correctly diagnosed as the Chytodesmidae, but the assumption that the species represented a new generic type, named *Schizodira*, was an error. Actually the species belongs to the genus *Docodesmus* Cook, although from Bollman's description its inclusion there could scarcely have been inferred. The "distinct notch" he noted between the third and fourth marginal area on each side of the first segment is very small (in the female at least) and might well escape notice, being no more conspicuous than the marginal irregularities of some other members of *Docodesmus*. Furthermore, Bollman's use of the word "crenulations," in referring to the shape of the outer margin of the lateral keels, is doubtful. "Indentation" would have been a more exact term, for the outer margins of segments 2–6, 8, 11, and 14 have two indentations setting off the three crenulations, and segments 7, 9, 10, 12, 13, and 15–19 have three indentations separating the four crenulations, as in the other species of *Docodesmus*.

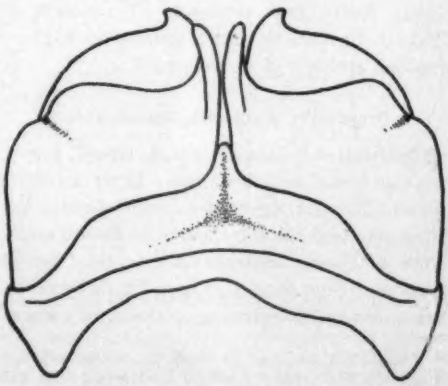


Fig. 1.—Gonopods (♂) of *Arinolus torynophor* Chamberlin, anterior view.

Docodesmus maculatus (Bollman)

Stenonia maculata Bollman, Proc. U. S. Nat. Mus. **11**: 336. 1888.
Platyrachus? maculatus Chamberlin, Bull. Mus. Comp. Zool. **62**: 216. 1918.
Schizodira maculata Loomis, Psyche **48**: 37–38. 1941.

Having finally located Bollman's species in the genus *Docodesmus*, we must reach a decision on the only other species of this genus known from Cuba. *Docodesmus cubensis* Loomis was founded on a mature female (Bull. Mus. Comp. Zool. **80**: 225–226, figs. 13, 14. 1937) when it was supposed to be the first Cuban species of the genus. It is closely allied to *maculatus* and eventually may be withdrawn into it after a study of more extensive material, but the present comparison appears to justify maintaining both species as valid. Outstanding differences of *maculatus* from *cubensis* are seen at the posterior end of the body, for the backwardly produced keels of segment 19 are small and acute, scarcely larger than any one of the four median tubercles of the posterior margin; between the keels of this segment there are six marginal tubercles (four in *cubensis*), with the outer tubercle on each side smaller than the median ones; the last segment is almost completely hidden by the preceding one, and the dorsum has two rounded median tubercles much smaller than the conic ones of *cubensis*.

Genus **Jeekelia**, n. name

A new name for *Melanodesmus* Loomis (Bull. Mus. Comp. Zool. **88**: 73. 1941), which is preoccupied by *Melanodesmus* Carl (Mem. Soc. Neuchatel. Sci. Nat. **5**: 908. 1914). *Jeekelia granulosa* Loomis is the only known species.

Genus **Prosopodesmus** Silvestri

Prosopodesmus Silvestri, Zool. Anz. **35**: 362. 1910.
Homodesmus Chamberlin, Bull. Mus. Comp. Zool. **62**: 222. 1918.

Prosopodesmus jacobsoni Silvestri

Prosopodesmus jacobsoni Silvestri, Zool. Anz. **35**: 362, figs. 6, 7. 1910.
Homodesmus parvus Chamberlin, Bull. Mus. Comp. Zool. **62**: 223. 1918.

This species appears to have been introduced from the Orient into the Western Hemisphere, where it now is found in Haiti, Puerto Rico, St. Eustatius, and Brazil.

ZOOLOGY.—*A new crawfish of the genus* Orconectes *from Louisiana.* (*Decapoda: Astacidae*).[1] GEORGE HENRY PENN, Tulane University. (Communicated by HERBERT FRIEDMANN.)

The new crawfish described here shows its closest affinities to *Orconectes clypeatus* (Hay) and thus represents the second species described which belongs to the subgenus *Faxonella* of Creaser. I am naming this new species in honor of the late George E. Beyer (1861–1926), first professor of zoology at Tulane University and a pioneer in exploring the zoology of Louisiana.

Orconectes (Faxonella) beyeri, n. sp.

Diagnosis.—Rostrum without lateral spines; rostrum broad, length averages three times its width. Thoracic region of carapace slightly less than one-third the total length of the carapace. Male with hooks on ischiopodites of third pereiopods only. First pleopod of form I male terminating in two rami: central projection a long sickle-shaped process bent mesially; mesial process much shorter, less than half the length of the central projection, bent in same direction; the two pleopods overlap each other in normal position. Annulus ventralis immovable, surface contours as in Fig. 7; sinus either dextral or sinistral.

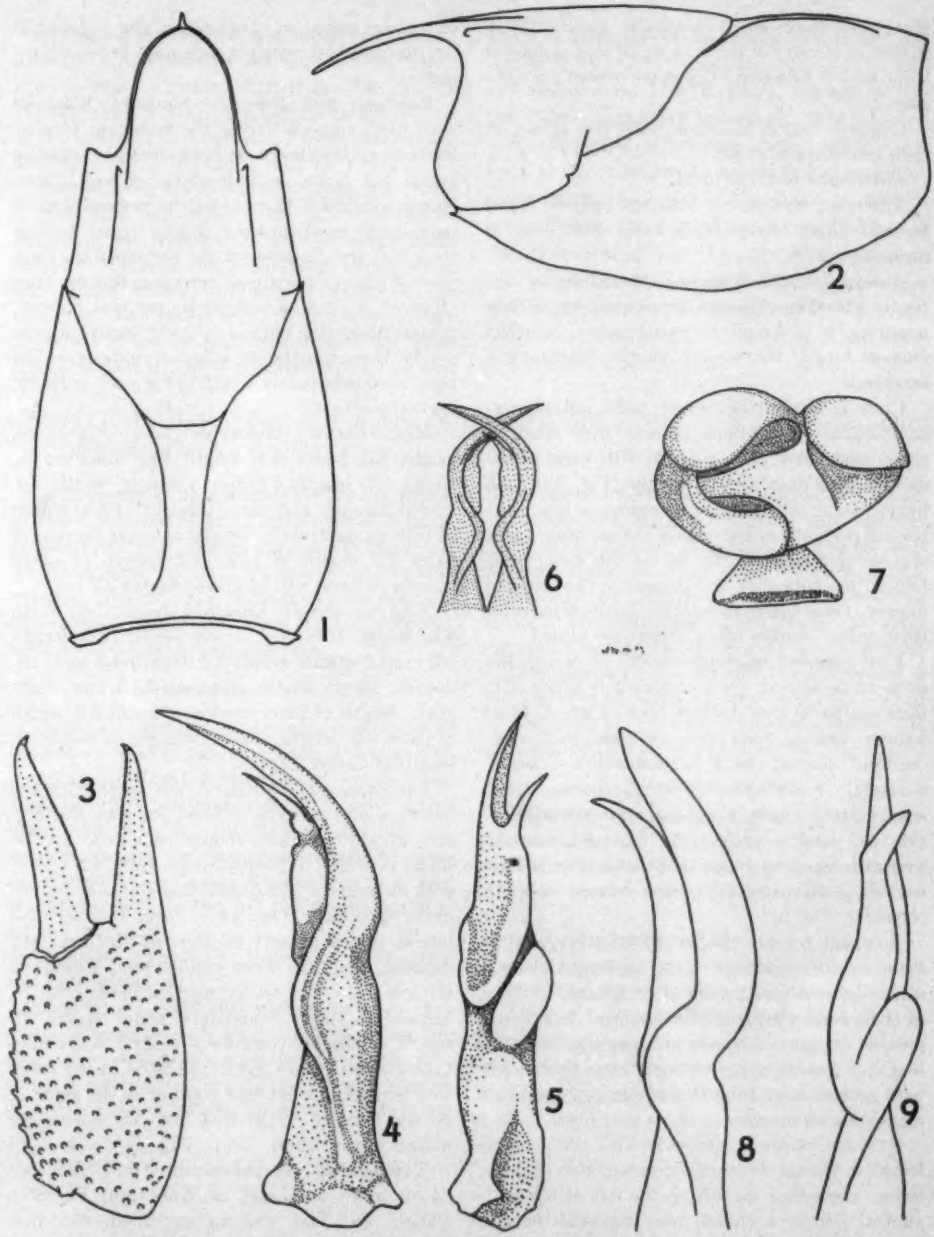
Holotypic male, form I.—Body subovate, not depressed (Figs. 1, 2). Abdomen narrower than thorax. Width of carapace at widest point slightly greater than depth in same region.

Areola broad (3.1 times longer than width), with five or six punctations in narrowest part; cephalic portion of carapace about 2.3 times as long as areola; length of areola about 30 percent of total length of carapace.

Rostrum without lateral spines; widest at base, margins raised but only slightly thickened, converging at acumen. Upper surface shallowly concave; no median carina. Acumen of moderate length.

Postorbital ridges prominent, terminating cephalad in small acute corneous spines. Bran-

[1] Received January 23, 1950. Aided by a grant from the University Council on Research of the Tulane University of Louisiana.



FIGS. 1–9.—*Oeconectes* (*Faxonella*) *beyeri*, n. sp.: 1, Dorsal view of carapace of holotype male; 2, lateral view of carapace of holotype male; 3, upper surface of chela of male; 4, caudal view of first pleopod of holotype male; 5, mesial view of first pleopod of holotype male; 6, caudal view of first pleopods of form I male in normal position to show overlapping of rami; 7, annulus ventralis of allotype female; 8, caudal view of first pleopod of form II males; 9, mesial view of first pleopod of form II male. Pubescence removed from all figures.

chiostegal spine small. Cephalic groove interrupted in vicinity of the very small cephalolateral spine on left side only; this spine absent on right side.

Cephalic region of telson with two spines in each caudolateral angle.

Antennules of usual form.

Antennae broken on holotype, nearly equal to total length of crawish in other specimens; of normal form.

Antennal scales extending beyond tip of rostrum; lateral margin straight, or nearly so, terminating in a small corneous spine; lamellar portion broad, the mesial margin describing a semicircle.

Chela somewhat depressed; palm inflated; inconspicuous punctations present over most of chela; surfaces of palm covered with small tubercles, largest near mesial margin (Fig. 3). Both fingers terminating in short corneous tips bent toward each other, the one on the movable finger slightly overhanging the tip of the immovable finger; no tubercles on opposable margins of fingers, these margins meeting fairly evenly for their entire lengths when fingers are closed.

First pleopod reaching middle of coxopodite of third pereiopod when abdomen is flexed. Tip terminating in two distinct rami (Figs. 4, 5) as follows: Central projection corneous, long, slender and sharply bent caudomesially ("sickle-shaped"); mesial process not corneous, much shorter, apex acute, also bent caudomesially beside the central projection; central projection over twice as long as mesial process. Pleopods in normal position lie with rami crossed as in *O. clypeatus* (Fig. 6).

Allotypic female.—Differs from the holotype male in the following respects: cephalolateral spine absent on both sides of carapace; tubercles of chela somewhat more conspicuous, larger; opposable margins of fingers not meeting for entire length, a gap being present near base; each finger with several large tubercles within proximal half of opposable margins.

Annulus ventralis subovate with the greatest length in the transverse axis; immovable (Fig. 7). Sinus originating slightly to the left of the midventral line in a trough near cephalic margin; from here sinus runs caudodextrad beneath an overhanging shelflike projection, then reappears to view before making an abrupt turn sinistrad nearly to midventral line, then turns sharply caudad to the posterior margin. Anterior margin of annulus raised on either side of the midventral line to form two rather conspicuous bulbous projections.

Paratypic male, form II.—Similar to holotype male in all respects except the following. Cephalolateral spines absent on both sides of carapace; areola not quite as wide, ratio of width into length equals 2.8. Hooks on ischiopodites of third pereiopods smaller, their length equal to less than half the diameter of the ischiopodite. First pair of pleopods without corneous tips on rami (Figs. 8, 9); mesial process longer and blunter, central projection blunt and thick; mesial process nearly three-fourths as long as central projection; pleopods barely overlapping each other in normal position.

Measurements.—Holotypic male: Carapace, height 6.3, width 6.5, length 13.7 mm; areola, width 1.3, length 4.1 mm; rostrum, width 1.6, length 3.2 mm; abdomen, length to tip of telson 15.0 mm; right chela, length of inner margin of palm 3.0, width of palm 2.2, length of outer margin of hand 8.0, length of dactyl 3.7 mm.

Allotypic female: Carapace, height 7.5, width 8.0, length 16.8 mm; areola, width 1.6, length 5.0 mm; rostrum, width 3.0, length 4.3 mm; abdomen, length to tip of telson 18.0 mm; right chela, length of inner margin of palm 3.3, width of palm 3.0, length of outer margin of hand 8.0, length of dactyl 3.7 mm.

Variation.—The 10 paratypes agree with the holotype and allotype in most respects, but certain minor variations should be noted. Areola: Ratio of width to length ranges from 2.7 to 3.6, with an average of 3.0 including the entire series of 12 specimens. One male, form II has small lateral spines present on the rostrum near the acumen, and has three caudolateral spines on the left side of the telson; another male, form II, has only a single caudolateral spine on the telson. The annulus ventralis is dextral in the allotype and one other female, sinistral in the other two females; the surface contour is the same in all the females except that one pair are mirror images of the other.

Type locality.—A roadside ditch on U. S. Route 84, 2 miles northeast of Naborton, De Soto Parish, La. This was an unshaded, mud-bottomed ditch in which the water was less than 12 inches deep, amber-colored and slightly turbid. Aquatic plants, including *Jussiaea* sp., were present, indicating the probability that the habitat is at least semipermanently wet.

Specimens examined.—A series of 12 from two localities in Louisiana as follows: De Soto Parish: 2 miles east Naborton, August 5, 1949, George H. Penn and Edward N. Lambremont (2 ♂ I, 2 ♂ II, 3 ♀); Natchitoches Parish: near Ajax, May 29, 1949, F. R. Cagle (4 ♂ II, 1 ♀).

Disposition of types.—The holotype male, form I (U.S.N.M. no. 90361), the allotype female (U.S.N.M. no. 90362), and one paratype male, form II (U.S.N.M. no. 90363), are deposited in the United States National Museum. Of the paratypes, two males, form II, and a female are deposited in the personal collection of Dr. Horton H. Hobbs, Jr., at the University of Virginia; and, one male, form I, one male, form II and one female from the type locality (TU 1440), and two males, form II (TU 1227), are retained in the Tulane University collections.

Relationships.—*Orconectes beyeri* clearly belongs to the subgenus *Faxonella* of *Orconectes* because of the small size of the mesial process in proportion to the central projection. *O. beyeri* is readily separated from the only other species in the subgenus, *O. clypeatus*, by the structure of the pleopods of the form I male, although both species have the same general structure of the rostrum and areola.

ORNITHOLOGY—*Two new genera of Furnariidae.*[1] JAMES L. PETERS, Museum of Comparative Zoölogy.

In preparing the manuscript for volume 7 of the *Check-list of birds of the world*, I have encountered two species among the Furnariidae that seem to require removal from their present generic assignments. These are *Asthenes maluroides* (d'Orbigny and Lafresnaye) and *Asthenes hellmayri* (Reiser).

Spartonoica, n. gen.

Diagnosis.—Similar to *Asthenes* Reichenbach, but tail much more graduated, the central pair of rectrices exceeding the outer pair by length of the wing, abruptly attenuated on their inner webs; upper and under tail coverts long and full, the latter concealing the lateral pair of rectrices. Similar also to *Leptasthenura* Reichenbach in degree of graduation of the tail, but bill longer, straighter, and less titlike.

Genotype.—*Synallaxis maluroides* d'Orbigny and Lafresnaye.

Remarks.—Though this species has been currently referred to *Asthenes*, the extremely graduated tail and abruptly attenuated rectrices distinguish *maluroides* from all the other species of *Asthenes* except *A. urubambensis* (Chapman), but in the latter the rectrices are gradually tapered, the tail coverts are not elongated, and the feet are relatively stouter. It appears more likely that *maluroides* may be more nearly related to *Leptasthenura*, but modified for a special type of habitat. The cinnamon-rufous crown certainly suggests a feature approached by several species of *Leptasthenura*, and likewise the absence of a guttural spot indicates no very close relationship to *Asthenes*, all of whose members except *A. maculicauda* (Berlepsch) possess this marking.

Gyalophylax, n. gen.

Diagnosis.—Similar to *Synallaxis* Vieillot, but tail composed of 12 rounded, instead of 10 pointed, rectrices; feet and legs much stouter; bill with culmen nearly straight and gonys ascending.

Genotype.—*Synallaxis hellmayri* Reiser.

Remarks.—This species is no doubt closely related to *Synallaxis*, as evidenced by the black gular patch and chestnut humeral patch, but is excluded by reason of its possession of 12 rectrices. Hellmayr placed it in *Asthenes*, but the very peculiarly shaped bill alone at once precludes it from any other existing genus among its near allies.

[1] Received February 1, 1950.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

435TH MEETING OF BOARD OF MANAGERS

The 435th meeting of the Board of Managers, held in the Cosmos Club on February 20, 1950, was called to order at 8:10 P.M., by the President, F. B. Silsbee. Also present were: N. R. SMITH, H. S. RAPPLEYE, J. A. STEVENSON, F. C. KRACEK, W. N. FENTON, A. T. MCPHERSON, W. R. WEDEL, J. I. HOFFMAN, J. S. WILLIAMS, F. A. WEISS, W. A. DAYTON, E. W. PRICE, MARGARET PITTMAN, O. B. FRENCH. F. M. SETZLER, and, by invitation, R. G. BATES, J. L. SHERESHEFSKY, and F. J. HERMANN.

The following appointments were announced by the President:

Archivist (3-year term): JOHN A. STEVENSON.
Appointed members of Executive Committee: N. R. SMITH and W. N. FENTON.
Board of Editors of the Journal: F. C. KRACEK was designated Senior Editor; W. F. FOSHAG to replace ALAN STONE; C. W. SABROSKY as Associate Editor for a term of 3 years, representing the Entomological Society of Washington.
Committee on Membership: R. G. BATES (chairman), M. BERNARD, C. A. BETTS, W. BURBANK, R. C. DUNCAN, REGINA FLANNERY, A. B. GURNEY, E. H. KENNARD, C. L. LEFEBVRE, C. W. REES, D. C. SMITH, L. A. SPINDLER.
Committee on Meetings: F. M. DEFANDORF (chairman), F. O. COE, M. HARRIS, L. G. HENBEST, B. J. OLSON, F. B. SCHEETZ.
Committee on Monographs: To January 1953—R. W. IMLAY, P. W. OMAN.
Committee on Awards for Scientific Achievement (T. D. STEWART, general chairman): *For the Biological Sciences:* T. D. STEWART (chairman), ELOISE B. CRAM, A. O. FOSTER, E. L. LITTLE, H. H. MCKINNEY, J. S. WADE. *For the Engineering Sciences:* W. RAMBERG (chairman) L. W. CURRIER, R. C. DUNCAN, O. S. READING, H. W. WELLS. *For the Physical Sciences:* R. D. HUNTOON (chairman), W. BLUM, M. GOLDBERG, R. J. SEEGER, E. H. VESTINE.
Committee on Grants-in-Aid for Research: J. L. SHERESHEFSKY (chairman), C. J. CONNOLLY, L. E. YOCUM.
Committee on Policy and Planning: To January 1953—W. A. DAYTON, N. R. SMITH.
Committee on Encouragement of Science Talent: To January 1953—A. H. CLARK, F. L. MOHLER
Committee of Auditors: W. D. SUTCLIFFE (chairman), C. L. GAZIN, R. L. SANFORD.
Committee of Tellers: F. A. CHACE, JR. (chairman), H. F. STIMSON, E. H. WALKER.

The Secretary presented the following report of actions and recommendations taken by the Executive Committee:

The meeting was called to order by the President, F. B. SILSBEE, at 5:50 P.M., at the Cosmos Club. Present were: N. R. SMITH, W. N. FENTON, H. S. RAPPLEYE, and F. M. SETZLER.

The Treasurer, H. S. RAPPLEYE, presented for discussion a budget for 1950. This budget, presented below, was finally approved, with the recommendation that it be presented to the Board of Managers.

RECEIPTS

	1949	*(Estimated) 1950*
Dues	$3,856.75	$3,800.00
Subscriptions	1,743.50	1,750.00
Interest & dividends	975.00	1,000.00
Sale of publications	987.61	250.00
	$7,562.86[1]	$6,800.00[2]

DISBURSEMENTS

Journal and Journal Office	$6,250.00	$3,350.00
Secretary	549.58	550.00
Treasurer	206.64	300.00
Subscription Manager and Custodian of Publications	37.34	50.00
Meetings Committee	345.13	500.00
Membership Committee	16.51	20.00
Science Fair	100.00	100.00
Science Calendar	—	10.00
	$7,507.20	$7,880.00
Operating deficit for 1950		$1,080.00
Second payment on 40-year index		500.00
Fireproof records cabinet		275.00
Estimated decrease in net worth		$1,855.00

[1] December reprints estimated.
[2] Plus charges to authors.

The Treasurer presented a communication from W. F. WILLOUGHBY, president of the Washington Sanitary Improvement Co., indicating a proposal made by the Colonial Investment Co. to purchase 95,000 shares of the Washington Sanitary Improvement Co. stock. The understanding was that if the Colonial Investment Co. could obtain the above-mentioned shares by 2:00 P.M. on March 15, 1950, they would be willing to purchase these shares for $32 per share. The Academy now holds 818 shares of Washington Sanitary Improvement Co. stock. The Executive Committee moved that the following recommendation be presented to the Board: "That the Treasurer of the Washington Academy of Sciences be authorized to deposit 818 shares of Washington Sanitary Improvement Company stock with the Washington Loan and Trust Company in accordance with the provisions outlined in a letter of January 27, 1950, from W. F. Willoughby, President of the Washington Sanitary Improvement Company, to the stockholders."

The meeting was adjourned at 7:56 P.M.

F. M. SETZLER, *Secretary.*

It was unanimously voted by the Board that the budget as presented by the Treasurer be approved.

Separate action was taken by the Board on the recommendation by the Executive Committee dealing with the sale of 818 shares of Washington Sanitary Improvement Company stock. After some discussion it was unanimously voted to approve the recommendation for the sale of these shares.

The President announced that at the next meeting of the Academy, on March 16, the annual Awards as well as the Certificates of Merit would be presented to the recipients.

The Committee on Membership presented the names of 18 nominees for resident and one for nonresident membership.

The Chairman of the Committee on Monographs recommended that the Custodian of Publications insert advertisements in various ornithological journals with regard to the sale of Friedmann's "The Parasitic Cuckoos of Africa," the Academy's Monograph No. 1.

The Chairman of the Committee on Encouragement of Science Talent presented the following report, which was approved by the Board:

The Committee on Encouragement of Science Talent has examined the records of the 28 local contestants in the National Science Talent Search conducted by the Westinghouse Educational Foundation and Science Service.

The board of judges of the national search selected three honorable mention contestants from this group. In compliance with the terms of our agreement with Science Service these three contestants have been named as local winners. The committee has reviewed the records of these contestants and agrees that they are worthy of being named among the local winners.

One contestant, MILES DAVIS, son of WATSON DAVIS, director of Science Service, would have been selected as a national search winner but was disqualified by reason of his relation through his father to one of the sponsoring agencies. The committee has reviewed the record of this contestant and unanimously agrees that his record justifies selection as a local winner.

The Committee reviewed the records of those local contestants not selected on a national basis and concluded that two additional local contestants had demonstrated science talent worthy of recognition by the Academy.

The Committee, as a result of its study, recommends the following persons to receive the Certificate of Merit of the Academy:

Miles Davis (age 16, Central High School), for science talent demonstrated by his studies of the accuracy of visual variable-star observations.

William Edward Drissel (age 16, Gonzaga High School), for science talent demonstrated by his study of optical instruments.

Phil Stratford Work (age 17, Western High School), for science talent demonstrated by his study of the staining of fungus media.

Patricia Morse Federico (age 16, Woodrow Wilson High School), for science talent demonstrated by her study of cancer.

Donald Jason Byers (age 17, Woodrow Wilson High School), for science talent demonstrated by his tests in a small scale wind tunnel.

Paul Douglas Sheats (age 17, Woodrow Wilson High School), for science talent demonstrated by his analysis of the erosional mechanics of a small stream.

The Committee further recommends that the Secretary of the Academy be authorized to furnish a letter of recommendation for each of the above to the colleges or universities of their choice, indicating that they are recipients of the Academy's Certificate of Merit and that they are considered worthy of consideration for scholarship awards by the college or university.

It is recommended finally that suitable public notice of these selections be disseminated. Draft of an appropriate news release for local newspapers is attached.

MARTIN A. MASON, *Chairman.*

DR. MASON also suggested that this year the Science Fair sponsored by the Academy issue an identification card to be presented to the winners. This took the form of a motion that the Academy provide certificates in recognition of the Science Fair Winners, which was approved by the Board. He also reported that arrangements have been made for the Science Fair to be held May 15–19, 1950, in the Auditorium of the Department of Commerce.

Six nominees were elected to membership in the Academy.

The Secretary reported the following deaths: GEORGE S. RICE, formerly of the Bureau of Mines, on January 3, 1950 (elected December 22, 1924; on retired list December 31, 1937); CLARENCE A. REED, Plant Industry Station, Beltsville, Md., on January 14, 1950 (elected May 13, 1946).

The Secretary also reported the nominations for Vice-Presidents of the Academy by two of the Affiliated Societies:

Medical Society of the District of Columbia.... FREDERICK O. COE

Washington Section, American Society of Mechanical Engineers....RICHARD S. DILL

The nominees were unanimously elected.

The Senior Editor of the Journal urged that more papers be submitted for publication in the JOURNAL.

A discussion was held with regard to the creation of a central office to handle the various duties, such as the Secretary and Treasurer offices for the Academy and the Affiliated Societies. The Board approved a motion that a committee be appointed by the President to explore the possibility of the creation of such a central office.

The meeting was adjourned at 10 P. M.

436TH MEETING OF BOARD OF MANAGERS

The 436th meeting of the Board of Managers, held in the Cosmos Club on March 20, 1950, was called to order at 8:10 P. M., by the President, F. B. SILSBEE. Also present were: N. R. SMITH, H. S. RAPPLEYE, J. A. STEVENSON, F. C. KRACEK, F. M. DEFANDORF, W. R. WEDEL, C. F. W. MUESEBECK, C. A. BETTS, R. S. DILL, E. W. PRICE, MARGARET PITTMAN, F. M. SETZLER, and, by invitation, R. G. BATES and L. W. PARR.

The following appointments were announced by the President: H. L. CURTIS (Chairman), NORMAN BEKKEDAHL, and HOWARD S. RAPPLEYE to serve as a committee to examine the desirability of establishing a central secretarial office to be used jointly by the Academy and a number of its affiliated societies.

The Committee on Membership presented the names of 17 nominees for resident and 1 for nonresident membership.

Nineteen individuals whose names had formerly been proposed were elected to membership.

The Secretary reported the following deaths: HENRI F. PITTIER, of Caracas, Venezuela, on January 27, 1950 (elected May 17, 1915; elected to honorary membership June 9,1939); CARLOS DE LA TORRE, of Havana, Cuba, on February 19, 1950 (elected to honorary membership June 9, 1939).

The Secretary read a letter from CHARLES WEIR, JR., 1949 recipient of the Academy's Certificate of Merit, describing his scholastic experiences at the University of California at Los Angeles.

The Treasurer reported the purchase of a fireproof vault for his files, as well as a typewriter.

The Archivist, J. A. STEVENSON, reported the transfer of the Academy's archival material from the previous Archivist, NATHAN R. SMITH, and indicated that a considerable reorganization of these records is now being made.

The meeting was adjourned at 9 P.M.

F. M. SETZLER, *Secretary*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting on January 24, 1950, elected the following officers: President, W. MONTAGUE COBB (reelected); Vice President, WALDO R. WEDEL; Secretary, WILLIAM H. GILBERT, JR.; Treasurer, MARGARET C. BLAKER (reelected); Councilors to the Board of Managers, CORNELIUS J. CONNOLLY, JOHN M. CORBETT, CARL F. MILLER (reelected), MARK HANNA WATKINS, EUGENE C. WORMAN, JR. (reelected); Representative to the Washington Academy of Sciences, WALDO R. WEDEL.

A report of the membership and activities of the Society since the last annual meeting follows:

Life members, 1; Active members, 78; Associate members, 18; Total, 97. This represents an increase of 10 since last year.

The members elected during the year were: Active members: DR. SIDNEY ADAMS, CARROLL M. BRODSKY, JOHN M. CORBETT, JOHN H. COX, MISS ELIZABETH DEGROAT, MISS IRENE DIGGS, DR. DAVID C. GRAHAM, DR. ELEANOR P. HUNT, JOHN T. MCGEE, JOHN PURCELL, ANDERS TEJLER, DR. EUGENE C. WORMAN, JR.; Associate members: RALPH SOLECKI, C. MALCOLM WATKINS.

The Society records its deep sense of loss at the deaths of Father JOHN M. COOPER, a past-president of the Society and member since 1922, and DR. RILEY D. MOORE, member since 1922.

The report of the Treasurer follows:

Income:		
A.S.W. dues collected	$95.00	
Dues from member, status in doubt	6.00	
Interest, Perpetual Building Association	60.14	
Dividends, Washington Sanitary Improvement Co.	21.00	
Dividends, Washington Sanitary Housing Co.	12.00	
Interest, U. S. Savings Bonds	12.50	
Sale of Old Series *Anthropologists*	6.00	
		$212.64
Cash in bank		295.51
		$508.15

Expenditures:		
A.A.A. dues paid for Secretary, Treasurer and 1 life member	15.00	
Speakers' expenses	116.34	
Incidental meeting expenses	16.75	
Refund to member	5.00	
Printing and mailing notices	46.54	
Flowers for funerals	18.23	
Secretary's expenses	32.25	
Treasurer's expenses	4.73	
		225.84
Balance in bank		$282.31
Assets:		
Funds invested in Perpetual Building Assn.	$2,000.00	
42 shares Washington Sanitary Improvement Co. (par value $10 per share)	420.00	
2 shares Washington Sanitary Housing Co. (par value $100 per share)	200.00	
U. S. Savings Bond, ser. G	500.00	
Cash in bank	282.31	
Total as of December 31, 1949		$3,402.31
Total as of December 31, 1948		3,415.51
Decrease		13.20
Less Bills outstanding:		
To A.A.A. (subscription to *American Anthropologist*, 1950)	$5.00	
To be allocated on behalf of member, status in doubt	6.00	
		11.00
Net decrease		24.20

All regular meetings were held at the U. S. National Museum. The programs for the first part of the year were arranged by DR. GORDON R. WILLEY; for the second part by DR. EUGENE C. WORMAN, JR.

Titles of the papers presented before the regular meetings of the Society were:

January 26, 1949, A. I. HALLOWELL, *Cultural variables and spatial orientation.*

February 15, 1949, HARRY TSCHOPIK, *Chucuito, an Aymara village in Southern Peru* (motion pictures and records).

March 15, 1949, JOHN H. COX, *Aspects of Early Yangtze Valley culture revealed by recent excavations at Ch'ang-Sha* (slides).

April 19, 1949, C. S. COON, *Recent anthropological reconnaissance in Iraq and Iran* (slides).

May 17, 1949, A. H. SCHULTZ, *The evolution of human development* (slides).

October 18, 1949, CARL SCHUSTER, *A series of significant correspondences between Old and New World design* (slides).

November 15, 1949, P. O. PEDERSEN, *Ecological and racial aspects of Eskimo dentition, based upon studies in East and West Greenland* (motion pictures).

The Society decided on a general plan to cut down errors in the mailing of notices. The Secretary was empowered to negotiate with the American Anthropological Association in the sale of Old and New Series *Anthropologists* now in the Society's possession. Certain stipulations as to price and other conditions were made. The President was instructed to appoint one member to help the Secretary in these matters. It was also decided that the President should appoint a committee to make recommendations on the many necessary changes in the bylaws.

MARSHALL T. NEWMAN, *Secretary.*

Obituaries

ORATOR FULLER COOK, agriculturist, botanist, and zoologist, was born at Clyde, N. Y., on May 28, 1867. He died in his home at Lanham, Md., on April 23, 1949, following a short and supposedly minor illness. His immediate surviving relatives are a son, Robert C. Cook, editor of the *Journal of Heredity*, and two daughters, Mrs. Elizabeth Upton, of Lanham, Md., and Mrs. Helen Moore Newman, of Chicago, Ill.

Cook was graduated from Syracuse University in 1890 and continued there as instructor for one year. During this time he studied and worked with Prof. L. M. Underwood, and the many interests in botany and zoology then aroused remained active throughout his life. In 1930 the University honored him with the D. Sc. degree.

He was a member of the American Association for the Advancement of Science; the American

Genetic Association; the Botanical Society of America; the Association of American Geographers; the Washington Academy of Sciences; and the Anthropological, Biological, Botanical, and Entomological Societies of Washington; and was honorary assistant curator of cryptogams and custodian of Myriapoda in the U. S. National Museum.

From 1891 to 1898 he was employed as special agent of the New York State Colonization Society and spent much of the time in Liberia, making three voyages there, to prepare for repatriation of the American Negro. In 1898 he entered the U. S. Department of Agriculture, and here he spent the remainder of his professional career, becoming a member of a group of young scientists among whom were such men as L. J. Briggs, G. N. Collins, F. V. Coville, David Fairchild, L. O. Howard, T. H. Kearney, Theobold Smith, W. T. Swingle, and M. B. Waite, to name but a few, whose work was to have a tremendous and imperishable effect on agriculture.

For several years he was in charge of seed and plant introduction and of tropical agricultural investigations of the Department of Agriculture, following which he was made head of an office that bore several titles, all of them covering the fields of rubber, cotton, and tropical crop plant investigations; he remained in this capacity until 1934 when he was transferred to the Division of Plant Exploration and Introduction. Retirement came in 1937 at the age of 70, but this did not mean cessation of work, for he continued to appear at his office with almost as great regularity as had been his wont.

Few men of his time had wider interests or more profound knowledge of many biological subjects, and these led to extensive travel throughout the Central American countries, Puerto Rico, Haiti, Peru, Egypt, Liberia, Persia, and China, as well as the cotton-growing regions of the United States. He became an authority on modern and pre-Columbian tropical agriculture, and his researches did much to solve the questions of how the Inca, Maya, and related peoples maintained themselves, and of the origins of certain tropical plants. At an early date he foresaw what was thought to be the impossible cutting off of the supplies of rubber from the Orient, and was a strong and ever-active proponent of establishing high-yielding varieties of the Para rubber tree in plantation form in the American Tropics and of developing production from other tropical and subtropical species of this hemisphere.

Although professing to have less natural interest in the cotton-growing industry than in his more tropical researches among plants and animals, nevertheless he gave to it by far the largest portion of his time, and his greatest contributions to the economy of the country were made in this field. His work with cotton began at the time when the cotton-boll weevil was beginning to make its entry into this country from across the Rio Grande. Through studies relating to the insect, he eventually changed the generally accepted methods of wide-spaced plantings to very much closer spacings in the row that produced crops before the weevils appeared in large number, lessened the number of pickings, and effected other economies. New and better varieties of cotton, some of which are widely planted today, were introduced or bred from those already here. The "one-variety cotton community" was an important improvement over the indiscriminate planting of many varieties, assuring continuous supplies of pure planting seed, better ginning and a less variable staple length, for which more uniform prices are paid.

Dr. Cook was a tireless worker and remarkably keen observer, never without a sheaf of small note paper on which observations and ideas were recorded, later to be filed under their proper headings. The writer does not recall of his ever taking a vacation for change of scene and relief from work. This was obtained, instead, by intermissions of varying length during which an entirely different subject would be the center of attention. From such digressions came many systematic and other studies on myriapods and palms, in both of which groups he was an international authority. His writings also relate to human colonization; sociology; evolution; genetics; biological nomenclature; horticultural aspects of miscellaneous tropical economic plants; the botany of the lower plants, the myxomycetes and mosses; and to structural characteristics, diversities, habits, and classification of many of the higher plants and of numerous arthropods. These literary labors total almost 400 articles and books.

Dr. Cook lived simply and with an unbounded love for the country. He disliked the restraint and artificiality of city life and shunned large crowds and social gatherings. One of his greatest pleasures was the collecting of old and rare books, which he indulged in on all his journeys and at home, gathering many treasures from which he drew ideas and references for his writings. He also was an ardent collector of the palms and

myriapods on which he worked. Endowed with a strong artistic sense, which manifested itself in many ways, on a trip to China in 1919 he first saw and admired the curious gnarled root and branch formations the cultured Chinese gathered, often enhanced in beauty by judicious carving, shaping, or polishing, and mounted as art objects under the name of "Frame Mountains." From then on he produced many of these ornamental pieces, working on them while his mind was occupied with thoughts of the subject on which he was then writing, the two projects progressing together to his satisfaction.

Dr. Cook held the friendship and esteem of a large number of people who mourn his passing with the knowledge that the world has lost one of its great scientists and scholars.

H. F. LOOMIS.

PERLEY G. NUTTING.—In the death of Dr. Perley Gilman Nutting, on August 8, 1949, the science of physics has lost one of its pioneers in the physics of light, the Geological Survey has lost one of its able and active investigators in the physics and chemistry of clays, and many of us have lost a dear friend.

Nutting was born at Randolph, Wis., on August 22, 1873, son of Charles and Cordelia (Gilman) Nutting. He was of early American pioneering stock, a descendant of John Nutting who left Nottinghamshire, England, in the company of John Winthrop, and settled in Groton, Mass., in 1632.

He received his bachelor's degree from Stanford University in 1897 and his master's degree a year later from the University of California. He spent a year at Göttingen, Germany, as Whiting fellow of the University of California, and with another fellowship studied at Cornell, where he received his doctor's degree in 1903.

He started his professional career in July 1903 at the National Bureau of Standards, where he began his work in optical research. Here he grew to have an intense and devoted interest in the fundamental physical problems of illumination and vision. His contributions to the understanding of the phenomena of light brought him a world-wide reputation and led to his occupying a high professional position among American physicists. While at the Bureau of Standards he made determinations, important in spectroscopy, of the relation between the internal energy of the light source and the line intensity; in visual optics, he determined and formulated the relation between light sensation and the radiant source of light. He invented a colorimeter and a spectrophotometer. His spectrophotometer was the first instrument to measure color in absolute terms; i.e., as intensities of different wave lengths of light, rather than by comparison with arbitrary reference standards. The Hilger-Nutting spectrophotometer is today a popular instrument. He designed a high precision lens testing bench, which became standard equipment in making and testing lenses. In 1912 he published a summary of this work in his *Outlines of applied optics*, a very useful and practical textbook.

The value of his work led to his being called to important positions with commercial organizations. In 1912 he went to the Eastman Kodak Co. to help Dr. C. E. K. Mees organize a new research laboratory in photography, assuming charge of the physics section. From 1916 to 1920 he organized and was the director of the research laboratory of the Westinghouse Electric and Manufacturing Co., for which he built up a staff of more than 90 research scientists. In 1920 he became a practicing consultant, largely in the field of lighting equipment for motion-picture studios. He developed a 100,000-candle-power incandescent light, the largest made up to that time, for use in color photography.

Having spent over 20 years in study of the theory of light and its practical application, a field of activity that brought him renown and high professional position, Dr. Nutting then turned his busy and inquiring mind to other fields of science. In 1924 he spent a year as consulting physicist at the Fixed Nitrogen Research Laboratory in Washington, and in 1925 he went to the Geological Survey, where he spent the last eighteen years of his professional life, devoting himself to the examination of the clay minerals and their practical application. His many papers on clays have been widely read. One of the diagnostic properties of clays he studied extensively and carefully was dehydration at various temperatures. His method of measuring the bleaching capacity of activated clays has been much used. His success in this work was the result of his imagination and flexibility of mind, his unwillingness to accept any task or line of study as an impossible one for him, and his intense devotion to the study of clay minerals. This devotion continued after his retirement in August 1943, in work with clays at home, frequent trips into the

field to gather new specimens, and in his many visits to the Survey to talk with his former associates. The circumstances of his death are indicative of his devotion to the study of clays; he had just left the Survey and was on the way to the National Museum, perhaps to obtain additional specimens or to consult with the staff there on matters pertaining to clays.

Dr. Nutting had the distinction of being a founder and the first president (1917–19) of the Optical Society of America. He also belonged to the Geological Society of Washington, the American Physical Society, the American Astronomical Society, the British Optical Society, the Franklin Institute, the American Chemical Society, and the Washington Academy of Sciences. The diversity of the fields of these scientific organizations reveals his breadth of knowledge and interest.

Dr. Nutting was married twice. His first marriage was on October 12, 1906, to Edith Eva, daughter of Capt. George Lightfoot, Royal Navy. She died in 1924, leaving four sons: Ian Fitzallen, Kelvin Lightfoot, Edward Volney, and Perley Gilman Nutting, Jr. His second marriage was on April 7, 1928, to Julia Elizabeth, daughter of Samuel S. Stouffer, of Sharpsburg, Md.

His many friends on the Survey and in the Geological Society of Washington mourn the passing of this great physicist.[1]

ROLLIN E. STEVENS.

CHARLES J. CLIFFORD, mathematician, U. S. Coast and Geodetic Survey, died during the evening of December 21, 1949, at George Washington University Hospital in Washington, D. C., after an illness that had kept him away from his desk for less than three months. He was buried in Arlington National Cemetery.

Clifford was born in Denver, Colo., on August 28, 1894, the son of James and Caroline Drummond (Veale) Clifford. He graduated from Union High School No. 1 of Adams County, Colo., in June 1914. He was variously employed until he entered the military service on September 20, 1917. Discharged on account of physical disability on December 19, 1917, he returned to his home. He became a rural mail carrier on March 1, 1918, and worked out of Derby, Colo., until September 15, 1920, when he resigned in order to attend the University of Colorado. Clifford received his B.S. degree in electrical engineering in June 1924 and, after two minor engineering assignments entered the Federal service as a junior mathematician on July 25, 1925, being assigned to the section of leveling of the Coast and Geodetic Survey.

During the nearly 25 years of his service with the Survey, Clifford progressed through the grades of assistant and associate mathematician, attaining the rating of mathematician in 1941. During the most of this period Mr. Clifford was concerned with the processing of the field data of precision leveling and in the interpretation of the results, especially when repeat leveling revealed earth movement.

Clifford assisted in the special adjustment of the first-order level net of the United States in 1927. Again, in 1929, he worked on the special and general adjustments of the combined level nets of the United States and Canada. In 1940 and 1941 he undertook a complete study and readjustment of all the first-order leveling, both by the Mississippi River Commission and the Coast and Geodetic Survey, in the alluvial valley of the Mississippi River.

For a considerable period of time Mr. Clifford's work has included the preparation of material for the *Bibliography of geodesy* for the International Union of Geodesy and Geophysics. He also attended the meetings of that organization in Oslo in 1948.

His memberships in various organizations included the American Association for the Advancement of Science, the Polar Society, and the American Geophysical Union. He was elected to membership in the Washington Academy of Sciences on January 14, 1946.

Clifford was a member and past commander of Cissel-Saxon Post, American Legion, at Silver Spring, Md., and also a member of the Maryland State Guard.

His marriage to Lena Marie Andres took place on September 18, 1918. He is survived by his widow; two sons, Eugene and Charles; his mother; his brother, Joseph M. Clifford; a half-brother, William M. Garrison, and a half sister, Mrs. Jesse Collins.

HOWARD S. RAPPLEYE.

[1] Communicated to the Geological Society of Washington on February 8, 1950.